



# **Ground Condition Consultants**

**LAND AT 31A NORTH STREET, EMSWORTH**

**GEOTECHNICAL DESIGN REPORT**

**MARCH 2022**

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| Site Investigation Factual Report                                       |                                         |
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## Contents

|           |                                                      |           |
|-----------|------------------------------------------------------|-----------|
| <b>0.</b> | <b>EXECUTIVE SUMMARY .....</b>                       | <b>5</b>  |
| <b>1.</b> | <b>INTRODUCTION.....</b>                             | <b>6</b>  |
| 1.1       | INSTRUCTION.....                                     | 6         |
| 1.2       | PROPOSED USE .....                                   | 6         |
| 1.3       | REPORT SCOPE AND LIMITATIONS .....                   | 6         |
| 1.4       | PREVIOUS REPORTS .....                               | 7         |
| 1.5       | SITE LOCATION AND DESCRIPTON.....                    | 7         |
| 1.6       | DOCUMENTATED GROUND CONDITIONS .....                 | 7         |
| <b>2.</b> | <b>FIELDWORK SUMMARY OF SCOPE AND RATIONALE.....</b> | <b>8</b>  |
| 2.1       | RATIONALE AND SUMMARY OF SCOPE .....                 | 8         |
| 2.2       | SAMPLING .....                                       | 8         |
| 2.3       | SITE INVESTIGATION STANDARDS .....                   | 8         |
| <b>3.</b> | <b>GROUND CONDITIONS ENCOUNTERED.....</b>            | <b>9</b>  |
| 3.1       | SOIL CONDITIONS .....                                | 9         |
| 3.2       | OBSTRUCTIONS .....                                   | 10        |
| 3.3       | GROUNDWATER CONDITIONS .....                         | 10        |
| 3.4       | VISUAL/OLFACTORY EVIDENCE OF CONTAMINATION .....     | 10        |
| <b>4.</b> | <b>MATERIAL PROPERTIES.....</b>                      | <b>11</b> |
| 4.1       | INTRODUCTION.....                                    | 11        |
| 4.2       | GEOTECHNICAL TESTS .....                             | 11        |
| 4.3       | MATERIAL PROPERTIES.....                             | 11        |
| <b>5.</b> | <b>FOUNDATION AND GROUND ENGINEERING .....</b>       | <b>18</b> |
| 5.1       | INTRODUCTION.....                                    | 18        |
| 5.2       | FOUNDATIONS.....                                     | 18        |
| 5.3       | OTHER GEOTECHNICAL CONSIDERATIONS .....              | 22        |
| <b>6.</b> | <b>cONCLUSIONS AND RECOMMENDATIONS.....</b>          | <b>23</b> |
| 6.1       | GEOTECHNICAL .....                                   | 23        |

|            |                                    |           |
|------------|------------------------------------|-----------|
| <b>6.2</b> | <b>SHALLOW FOUNDATIONS .....</b>   | <b>23</b> |
| <b>6.3</b> | <b>GROUND FLOOR SLABS.....</b>     | <b>23</b> |
| <b>6.4</b> | <b>CONCRETE AGGRESSIVITY .....</b> | <b>24</b> |

### **List of Tables**

|            |                                                                                     |    |
|------------|-------------------------------------------------------------------------------------|----|
| Table 2.1  | Exploratory hole location rationale .....                                           | 8  |
| Table 3.1  | Summary of encountered ground conditions .....                                      | 9  |
| Table 4.1  | Summary of Geotechnical Testing .....                                               | 11 |
| Table 4.2. | Results of the standard penetration testing – London Clay Formation..               | 12 |
| Table 4.3. | Results of the Atterberg limits testing – London Clay Formation .....               | 13 |
| Table 4.7. | Characteristic Geotechnical Parameters .....                                        | 17 |
| Table 5.1. | Minimum depth of foundations for high volume change soil (after NHBC<br>2020) ..... | 18 |
| Table 5.2. | Partial Factors Applied to the Bearing Resistance Analysis.....                     | 19 |
| Table 5.3. | Ground model and characteristic geotechnical parameters .....                       | 20 |
| Table 5.4. | Summary of ULS bearing resistance checks .....                                      | 20 |
| Table 5.5. | Results of the settlement analyses.....                                             | 21 |
| Table 5.6  | Void dimensions (from NHBC 2020) .....                                              | 22 |

### **List of Figures and Appendices**

**FIGURE 1: INVESTIGATION LOCATION PLAN**

**FIGURE 2: SPT V DEPTH**

**FIGURE 3: UNDRAINED SHEAR STRENGTH V DEPTH**

**APPENDIX 1: REPORT CONDITIONS**

**APPENDIX 2: ENGINEERING LOGS**

**APPENDIX 3: GEOTECHNICAL TEST CERTIFICATES**

**APPENDIX 4: GEOTECHNICAL CALCULATIONS**

## 0. EXECUTIVE SUMMARY

|                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Brief                                                                                                                                                                                                                                                                                                              | The brief was to undertake a site investigation and assessment to identify geotechnical conditions that may affect the proposed development. The geotechnical sections of this report provide a detailed assessment of the materials present beneath the site and present characteristic parameters that should be used in design of all geotechnical facets of the proposed development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Current Site Status                                                                                                                                                                                                                                                                                                | The site is located on land at 31A North Street, Emsworth PO10 7DA, at National Grid reference 474919, 106078. The site covers approximately 0.1 hectares at an elevation of approximately 8m above Ordnance Datum (AOD) and comprises shared hardstanding entrance way; hardstanding courtyard area in the central portion; single storey brick-built warehouse / workshop structure in the north; two storey brick built commercial unit adjoining workshop to the south along the eastern boundary; two-storey brick built office building on the western side of the courtyard, along the western boundary.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Geology                                                                                                                                                                                                                                                                                                            | Published geological records for the area (British Geological Survey, July 2018) indicated that the site is underlain by superficial River Terrace Deposits (sand, silt and clay) and superficial Head Deposits (clay and gravel) along the eastern boundary. Bedrock deposits of the London Clay Formation (clay, silt and sand) are shown to underlie the site.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Scope of Investigation                                                                                                                                                                                                                                                                                             | The site investigation works were undertaken by GCC on the 11 <sup>th</sup> February 2022. <ul style="list-style-type: none"> <li>3no. windowless sample boreholes (WS201-203) to a maximum depth of 5.0mbgl.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Conclusions and Recommendations                                                                                                                                                                                                                                                                                    | <p>The ground investigation revealed the site to be underlain by Made Ground over London Clay Formation (LCF) to the full depth of the ground investigation.</p> <p>Groundwater was encountered during the ground investigation at the interface between the Made Ground and the London Clay Formation. Groundwater has been set at 1.00mbgl for foundation design purposes.</p> <p>Based on the ground conditions encountered at the site, a shallow foundation is considered the most appropriate foundation solution for the proposed development.</p> <p>All foundations should be within the underlying natural stratum. The LCF was identified as being of high volume change potential, NHBC (2020) recommends a minimum foundation depth of 1.00m outside the zone of influence of any existing or recently removed trees or shrubs.</p> <p>Ultimate limit state bearing resistance analysis of strip foundations constructed at 1.00mbgl has been undertaken and gives ULS bearing resistances of 107 and 112kN/m<sup>2</sup> for a 0.60 and 1.00m wide foundation respectively.</p> <p>A serviceability limit state settlement analysis was carried out under foundation loadings equal to the ULS bearing resistances and indicates that settlements will be less than 25mm for all strip foundations up to 1.00m.</p> <p>A ground bearing floor slab is considered inappropriate due to the presence of the Made Ground and high volume change potential of the underlying LCF.</p> <p>Based on the descriptions of the materials encountered during the ground investigation, foundation excavations should remain stable in the medium term. However, in line with good engineering practice, foundation trenches should remain open for the minimum time possible before the placement of concrete.</p> <p>Chemical testing of the Made Ground and the LCF have shown them to be consistent with a Design Sulphate Classification of DS-4 and an Aggressive Chemical Environment for Concrete of ACEC-3s assuming static groundwater conditions.</p> |
| <p><i>This sheet is intended to provide a summary only of the initial indicative assessment study of the site in relation to ground contamination. It does not provide a definitive engineering analysis for the purposes of costing or construction and is subject to the limitation of the agreed brief.</i></p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

## **1. INTRODUCTION**

### **1.1 INSTRUCTION**

Ground Condition Consultants Ltd. (GCC) was commissioned by Parchow Groundworks Ltd in January 2022 to undertake a Ground Investigation and Geotechnical Design Report of a site located at 31A North Street, Emsworth, PO10 7DA.

The brief was to undertake a ground investigation and assessment to identify geotechnical conditions that may affect the proposed development. The report provides a detailed assessment of the materials present beneath the site and presents characteristic parameters that should be used in design of all geotechnical facets of the proposed development.

This report is prepared in line with the agreed brief and is subject to the report conditions shown in Appendix 1.

### **1.2 PROPOSED USE**

It is currently understood that the site is to be developed for commercial/retail use.

### **1.3 REPORT SCOPE AND LIMITATIONS**

This report is based upon the recent site investigation data detailed herein. The report presents an interpretation of the boreholes and laboratory data provided by the GCC ground investigation undertaken on the 11<sup>th</sup> February 2022. In addition, this report outlines the basic ground conditions encountered in the exploratory holes.

This information has been collated, processed and used to provide an interpretation of the ground conditions, with recommendations for foundation design for the proposed development.

The recommendations and opinions expressed in this report are based on the strata observed in the exploratory holes and the results of the site and laboratory tests. GCC takes no responsibility for conditions that have not been revealed by the exploratory holes, or which occur between them.

Whilst every effort has been made to interpret the conditions between investigation locations, such information is only indicative and liability cannot be accepted for its accuracy. Information provided from other sources is taken in good faith and GCC cannot guarantee its accuracy.

The information contained in this report is intended for the use of Parchow Groundworks Ltd and GCC can take no responsibility for the use of this information by any other party or for uses other than that described in this report.

#### 1.4 PREVIOUS REPORTS

RSK Environment Limited (RSK) undertook a combined contamination and geotechnical investigation of the site, reported in their Geo-environmental Site Assessment for Hampshire Homes Group Ltd, dated September 2018 (Ref: 305019 R02 (00)).

The RSK report contained a contamination assessment and a geotechnical assessment based on in-situ and limited laboratory data.

#### 1.5 SITE LOCATION AND DESCRIPTION

The site is located on land at 31A North Street, Emsworth PO10 7DA, at National Grid reference 474919, 106078. The site covers approximately 0.1 hectares at an elevation of approximately 8m above Ordnance Datum (AOD) and comprises shared hardstanding entrance way; hardstanding courtyard area in the central portion; single storey brick-built warehouse / workshop structure in the north; two storey brick built commercial unit adjoining workshop to the south along the eastern boundary; two-storey brick built office building on the western side of the courtyard, along the western boundary.

#### 1.6 DOCUMENTATED GROUND CONDITIONS

##### 1.6.1. Geology

Published geological records for the area (British Geological Survey, July 2018) indicated that the site is underlain by superficial River Terrace Deposits (sand, silt and clay) and superficial Head Deposits (clay and gravel) along the eastern boundary. Bedrock deposits of the London Clay Formation (clay, silt and sand) are shown to underlie the site.

##### 1.6.2. Previous Investigation

Investigation of the site by RSK in 2018 reported encountering 0.5-0.9m of Made Ground in all four investigation locations, 0.6-0.7m of Alluvium in two of the four locations, 0.3-1.5m of Head Deposits in all four locations and London Clay from between 1.2m and 2.2mbgl to the base of the investigation.

## **2. FIELDWORK SUMMARY OF SCOPE AND RATIONALE**

### **2.1 RATIONALE AND SUMMARY OF SCOPE**

The site investigation works were undertaken by GCC on the 11<sup>th</sup> February 2022 and were intended to obtain sufficient additional data to inform the foundation design for the proposed development. The scope and rationale of the ground investigation are presented in Table 2.1 below.

- 3no. windowless sample boreholes (WS201-203) to a maximum depth of 4.0mbgl.

**Table 2.1 Exploratory hole location rationale**

| <b>Location</b> | <b>Rationale</b>                                                                                                                                                                        | <b>Max depth (mbgl)</b> |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| WS201-203       | 3no windowless sample boreholes targeted to investigate the nature and stratigraphy of the subsurface materials in the areas of the proposed buildings and recover samples for testing. | 5.00                    |

The layout of the exploratory hole positions is presented in Figure 2.

### **2.2 SAMPLING**

Soil samples were recovered from various depths in the boreholes for geotechnical testing purposes.

### **2.3 SITE INVESTIGATION STANDARDS**

Methods employed during the site investigation were generally undertaken in accordance with BS10175, BS EN 1997-2 and BS5930.

### 3. GROUND CONDITIONS ENCOUNTERED

#### 3.1 SOIL CONDITIONS

Ground conditions encountered during the ground investigation differed from those identified in the published literature and comprised Made Ground over London Clay Formation, forming the basal unit of the investigation, with no identifiable River Terrace or Head Deposits. Variations in the thicknesses of the encountered strata are summarised in Table 3.1 and engineering logs are presented in Appendix 2.

**Table 3.1 Summary of encountered ground conditions**

| Location | Made Ground |               | London Clay Formation |               |
|----------|-------------|---------------|-----------------------|---------------|
|          | From (mbgl) | Thickness (m) | From (mbgl)           | Thickness (m) |
| WS201    | GL          | 1.00          | 1.00                  | >3.50         |
| WS202    | GL          | 1.60          | 1.60                  | >3.40         |
| WS203    | GL          | 1.50          | 1.50                  | >3.50         |

##### 3.1.1. Made Ground

Approximately 0.2-0.3m of concrete surfacing was encountered in all three investigation locations. A 0.1m thick layer of clayey sand with frequent brick fragments was encountered beneath the concrete in WS201 and a 0.1m thick layer of terracotta floor tiles was encountered beneath the concrete in WS202.

Beneath the surface layer of concrete and the thin layers of granular Made Ground locally encountered beneath them, the majority of the Made Ground comprised 0.7-1.2m of reworked natural soft dark grey silty gravelly clay with frequent brick fragments. This Made Ground is likely to represent the reworked River Terrace and Head Deposits originally present on the site.

##### 3.1.2. London Clay Formation

The London Clay Formation was encountered beneath the Made Ground in all of the investigation locations at between 1.0m and 1.5mbgl and formed the basal stratum in these locations with a maximum proven thickness of greater than 3.5m. The London Clay Formation comprised firm to stiff grey mottled brown Clay with occasional sand pockets and mudstone gravel.

### 3.2 OBSTRUCTIONS

No obstructions were encountered within the investigation locations.

### 3.3 GROUNDWATER CONDITIONS

Groundwater was encountered during the investigation at the base of the Made Ground in WS202 and WS203 at between 1.5mbgl and 1.6mbgl. Groundwater was monitored on completion of the investigation on the 11<sup>th</sup> February 2022 in WS1 and WS3, from the RSK investigation, at 0.92mbgl and 0.96mbgl, respectively.

### 3.4 VISUAL/OLFACTORY EVIDENCE OF CONTAMINATION

No visual or olfactory evidence of contamination was encountered within the boreholes.

## 4. MATERIAL PROPERTIES

### 4.1 INTRODUCTION

The geotechnical assessment and the subsequent foundation design recommendations will use the findings of the ground investigation and the results of the in-situ and geotechnical testing carried out in the boreholes and on representative samples of the material encountered.

### 4.2 GEOTECHNICAL TESTS

A programme of geotechnical laboratory testing was carried out on representative samples collected from the strata encountered during the ground investigation.

Details of the specific procedure used in each case are shown below in Table 4.1 and the geotechnical test certificates are presented in Appendix 3.

**Table 4.1 Summary of Geotechnical Testing**

| Test                                                  | Standard (BS1377:1990)<br>unless otherwise indicated | No. |
|-------------------------------------------------------|------------------------------------------------------|-----|
| Classification Tests                                  |                                                      |     |
| Atterberg Limits Tests                                | Part 2, Clause 4.4, 4.5 & 5.4                        | 6   |
| Total Shear Strength Testing                          |                                                      |     |
| Unconsolidated Undrained Triaxial Compression Testing | Part 7, Clause 8.4                                   | 3   |
| Chemical Tests                                        |                                                      |     |
| pH + SO <sub>4</sub>                                  | Part 3, Clause 5.3 & 9.0                             | 1   |
| BRE SD1 Suite                                         | Various                                              | 3   |

### 4.3 MATERIAL PROPERTIES

This section discusses the key geotechnical characteristics of each encountered stratum as determined from field observations, in-situ and laboratory geotechnical testing.

#### 4.3.1. Made Ground

Concrete surfacing and associated subbase were identified at all exploratory hole locations. Beneath the engineered surfacing a further 0.70 - 1.20m of reworked natural soft dark grey silty gravelly clay with frequent brick fragments was encountered.

No geotechnical laboratory testing was undertaken within the Made Ground as all foundations will be constructed beneath this potentially highly variable material.

#### 4.3.2. London Clay Formation

London Clay Formation (LCF) was encountered beneath the Made Ground at all exploratory hole locations and formed the basal unit of the ground investigation with a maximum proven thickness of > 3.50m (WS201 & 203). The LCF comprised firm to stiff grey mottled brown Clay with occasional sand pockets.

##### In-Situ Testing

Standard penetration testing (SPT) was undertaken throughout the LCF, the results of these tests are presented in Table 4.2 and on the engineering logs in Appendix 2.

**Table 4.2. Results of the standard penetration testing – London Clay Formation**

| BH No. | Depth (mbgl) | N-value | Principal Soil Type     | BH No. | Depth (mbgl) | N-value | Principal Soil Type     |
|--------|--------------|---------|-------------------------|--------|--------------|---------|-------------------------|
| WS201  | 1.00         | 12      | Grey mottled brown CLAY | WS202  | 4.00         | 16      | Grey mottled brown CLAY |
|        | 2.00         | 20      |                         |        | 5.00         | 16      |                         |
|        | 3.00         | 17      |                         | WS203  | 2.00         | 16      | Grey mottled brown CLAY |
|        | 4.00         | 19      |                         |        | 3.00         | 17      |                         |
|        | 4.50         | 21      |                         |        | 4.00         | 21      |                         |
| WS202  | 2.00         | 17      | Grey mottled brown CLAY |        | 5.00         | 20      |                         |
|        | 3.00         | 15      |                         |        |              |         |                         |

The standard penetration testing within the LCF returned SPT N-values of between 12 and 21. All the SPT data for the LCF has been included in the plot against depth (Figure 3). Careful inspection of the SPT data shows an increase of N-value with depth from N=12 at 1.00mbgl to N=20 at 5.00mbgl. This range of values should be adopted for the LCF.

##### Classification Testing

###### *Consistency Limits*

6no. representative samples of LCF underwent Atterberg limits testing to determine their consistency limits. The results are presented in Table 4.3 whilst the laboratory test certificates are located in Appendix 3.

**Table 4.3. Results of the Atterberg limits testing – London Clay Formation**

| Location | Depth (mbgl) | Liquid Limit $w_L$ (%) | Plastic Limit $w_P$ (%) | Plasticity Index $I_P$ (%) | % Passing the 425 $\mu$ m sieve | Corrected Plasticity Index (%) |
|----------|--------------|------------------------|-------------------------|----------------------------|---------------------------------|--------------------------------|
| WS201    | 1.50-2.00    | 70                     | 25                      | 45                         | 95                              | 43                             |
|          | 2.50-3.00    | 67                     | 26                      | 41                         | 100                             | 41                             |
| WS202    | 1.60-2.00    | 64                     | 25                      | 39                         | 96                              | 37                             |
|          | 2.50-3.00    | 67                     | 28                      | 39                         | 100                             | 39                             |
| WS203    | 1.50-2.00    | 49                     | 20                      | 29                         | 62                              | 18                             |
|          | 3.40-4.00    | 70                     | 18                      | 52                         | 100                             | 52                             |

The lowest plasticity index recorded in WS203 at 1.50-2.00mbgl was undertaken in sandy CLAY material and therefore is not considered representative of the LCF and will not be included in the description below.

The Atterberg limits tests returned plasticity indices of between 39 and 52% with liquid limits of 64 to 70%, which are consistent with a fine-grained material of high plasticity. After correction, to account for the >425 $\mu$ m content, the corrected range of plasticity indices is 37 to 52% which is consistent with a fine-grained soil of medium to high plasticity.

For design purposes the LCF should be treated as being of high volume change potential with a characteristic plasticity Index ( $I_{Pk}$ ) of 39%.

### Shear Strength

#### *Undrained Shear Strength*

3no. representative samples of the LCF underwent laboratory unconsolidated undrained triaxial compression testing to determine their undrained shear strength. The results are presented in Table 4.4 and the laboratory test certificates are located in Appendix 3.

**Table 4.4. Results of the UU Triaxial Compression Testing – London Clay Formation**

| Location | Depth (mbgl) | Bulk Density (Mg/m <sup>3</sup> ) | Cell Pressure (kN/m <sup>2</sup> ) | Undrained Shear Strength $c_u$ (kN/m <sup>2</sup> ) |
|----------|--------------|-----------------------------------|------------------------------------|-----------------------------------------------------|
| WS201    | 1.50-2.00    | 1.98                              | 35                                 | 65                                                  |
| WS202    | 2.50-3.00    | 1.99                              | 55                                 | 128                                                 |
| WS203    | 3.40-4.00    | 1.95                              | 75                                 | 125                                                 |

The results of the UU triaxial testing give  $c_{uk}$  values of 65 to 128kN/m<sup>2</sup> which are consistent with a medium to high undrained shear strength.

The laboratory test results have been augmented with  $c_{uk}$  values derived from the widely accepted empirical relationship:

$$c_u = f_1 \times SPTN$$

Where  $f_1$  is a correlation factor based on the  $I_{pk}$

Using a correlation factor of 4.5, all the undrained shear strength data has been plotted and reveals an increase in undrained shear strength with depth from 60kN/m<sup>2</sup> at 1.00mbgl to 120kN/m<sup>2</sup> at 5.00mbgl.

#### *Drained (Effective) Shear Strength*

The widely accepted relationship between drained shear strength and plasticity index for remoulded clays has been used to determine the effective shear strength parameters, where:

$$\phi'_k = 42 - (12.5 \text{ Log } I_{pk})$$

Taking the characteristic plasticity index of 27% will give a characteristic effective angle of shearing resistance ( $\phi'_k$ ) of 22°.

In terms of effective stress, the shear strength of a fine-grained soil can be considered as frictional, such that  $c'_k = 0\text{kN/m}^2$ .

### Other Geotechnical Parameters

#### *Modulus of Deformation ( $E_k$ )*

Using an  $E_k/c_{uk}$  ratio of 400 for the LCF gives an undrained Modulus of Deformation ( $E_{uk}$ ) of 24MN/m<sup>2</sup> at 1.00mbgl rising to 48MN/m<sup>2</sup> at 5.00mbgl.

CIRIA R 143 suggests that the drained modulus ( $E'_k$ ) should be taken as  $0.75E_{uk}$ . Therefore, an  $E'_k$  of 18MN/m<sup>2</sup> at 1.00mbgl rising to 36MN/m<sup>2</sup> at 5.00mbgl has been attributed to the LCF.

#### *Modulus of Volume Compressibility*

The coefficient of volume compressibility ( $m_v$ ) has been determined from the empirical relationship with the plasticity index ( $I_{Pk}$ ) and published data for similar materials giving an  $m_{vk}$  of 0.12m<sup>2</sup>/MN, which is indicative of a material of medium compressibility.

## 4.4 AGGRESSIVE GROUND SOIL CHEMISTRY

Chemical testing was carried out on 4no. representative samples of the materials encountered beneath the site in accordance with Box C10, BRE Special Digest 1. The results are summarised in Tables 4.5 and 4.6.

**Table 4.5 Results of the BRE SD1 testing**

| BH    | Depth (mbgl) | Stratum | pH  | Total Sulphate AS (% SO <sub>4</sub> ) | Total Sulphur TS (%) | Total Potential Sulphate TPS (%) | Oxidisable (Sulphate) (%) |
|-------|--------------|---------|-----|----------------------------------------|----------------------|----------------------------------|---------------------------|
| WS201 | 1.50-2.00    | LCF     | 8.0 | 0.040                                  | 0.025                | 0.075                            | 0.035                     |
| WS202 | 4.50-5.00    | LCF     | 8.0 | 0.131                                  | 0.710                | 2.130                            | 1.999                     |
| WS203 | 0.50-1.00    | MG      | 7.8 | 0.020                                  | 0.079                | 0.237                            | 0.217                     |

**Table 4.6. Summary of the results of chemical testing for concrete classification**

| Test                         | WS103         |
|------------------------------|---------------|
|                              | 0.30-0.50mbgl |
|                              | Made Ground   |
| pH                           | 9.8           |
| Water Soluble Sulphate (g/l) | 1.8           |

The amounts of oxidisable sulphides have been determined following the procedure documented in Paragraph C5.1.2 of BRE SD1. The results indicate that pyrite may be present in significant amounts within the LCF. Based on the maximum determined total potential sulphate and water soluble sulphate content Tables C1 and C2 of BRE SD1 give a Design Sulphate Classification of DS-4 and an Aggressive Chemical Environment for Concrete (ACEC) Class of AC-3s assuming static groundwater conditions in the fine-grained LCF.

#### 4.5 CHARACTERISTIC GEOTECHNICAL PARAMETERS

Based on the laboratory test results, in-situ testing and subsequent analysis a range of characteristic geotechnical parameters, which should be used in all geotechnical and foundation design calculations are presented in Table 4.7.

**Table 4.7. Characteristic Geotechnical Parameters**

| Stratum              | Geotechnical Parameter                              |           |             | Notes                           | Characteristic Value                                                       |
|----------------------|-----------------------------------------------------|-----------|-------------|---------------------------------|----------------------------------------------------------------------------|
| Made Ground          | Not provided as not considered in foundation design |           |             |                                 |                                                                            |
| Weald Clay Formation | Unit Weight $\gamma$                                |           |             | Lab UUT                         | 19kN/m <sup>3</sup>                                                        |
|                      | Shear Strength                                      | Undrained | $c_{uk}$    | Lab UUT & Relationship with SPT | 60kN/m <sup>2</sup> at 1.00mbgl rising to 120kN/m <sup>2</sup> at 5.00mbgl |
|                      |                                                     |           | $\phi_{uk}$ |                                 | 0°                                                                         |
|                      |                                                     | Drained   | $c'_k$      | Relationship with $I_{pk}$      | 0kN/m <sup>2</sup>                                                         |
|                      |                                                     |           | $\phi'_k$   |                                 | 22°                                                                        |
|                      | Modulus of Deformation                              | Undrained | $E_{uk}$    | 400 x $c_{uk}$                  | 24MN/m <sup>2</sup> at 1.00mbgl rising to 48MN/m <sup>2</sup> at 5.00mbgl  |
|                      |                                                     | Drained   | $E'_k$      | 0.75 x $E_{uk}$                 | 18MN/m <sup>2</sup> at 1.00mbgl rising to 36MN/m <sup>2</sup> at 5.00mbgl  |
|                      | Coefficient of Volume Compressibility               |           | $m_{vk}$    | Relationship with $I_{pk}$      | 0.12m <sup>2</sup> /MN                                                     |

## 5. FOUNDATION AND GROUND ENGINEERING

### 5.1 INTRODUCTION

The geotechnical assessment below relates to the details of the proposed development. It is currently understood that the site is to be developed for commercial use.

3no. windowless sample boreholes were undertaken across the site and indicated ground conditions to comprise Made Ground over London Clay Formation (LCF) to the full depth of the ground investigation. The LCF comprised firm becoming stiff grey mottled brown CLAY.

Groundwater was encountered during the investigation at the base of the Made Ground in WS202 and WS203 at between 1.50mbgl and 1.60mbgl. Groundwater was monitored on completion of the investigation on the 11<sup>th</sup> February 2022 in WS1 and WS3, from the RSK investigation, at 0.92mbgl and 0.96mbgl, respectively. The groundwater level will be set at 1.00mbgl for foundation design purposes.

Based on the ground conditions present beneath the site a traditional foundation is considered the most appropriate solution for the ground conditions encountered.

### 5.2 FOUNDATIONS

#### 5.2.1. Depth of Foundations

All foundations should be constructed beneath the Made Ground within the underlying LCF.

For foundations constructed within the LCF consideration will need to be given to its medium volume change potential identified from the consistency limits testing. NHBC guidance offers two foundation depth scenarios dependant on future planting regimes (Table 5.1).

**Table 5.1. Minimum depth of foundations for high volume change soil (after NHBC 2020)**

| Depth of Foundation | Description                                       | No Tree Planting Zone (m) |                       |                      |
|---------------------|---------------------------------------------------|---------------------------|-----------------------|----------------------|
|                     |                                                   | High Water Demand         | Moderate Water Demand | Low Water Demand     |
| 1.00                | No tree planting within Zone of Influence         | 1.25 x mature height      | 0.75 x mature height  | 0.50 x mature height |
| 1.50                | Restricted tree planting within zone of influence | 1.00 x mature height      | 0.50 x mature height  | 0.20 x mature height |

A minimum foundation depth of 1.00m is recommended, deepened if any of the proposed structures impinge upon the zone of influence of existing or recently removed trees (see Chart 3, Chapter 4.2, NHBC 2020). It should be noted that the ground investigation has shown a superficial layer of Made Ground between 1.00 and 1.60m thick which is more likely to control the required depth of foundation.

#### 5.2.2. Shallow Foundations – Ultimate Limit State (ULS) Bearing Resistance

The following ULS bearing resistance calculations have assumed a minimum foundation depth of 1.00m.

The ultimate limit state bearing resistance of the LCF has been calculated following the guidance presented in EC7.

The UK has implemented Design Approach 1 (DA1) of BS EN1997-1:2004 (Eurocode 7: Geotechnical Design), which requires two design combinations to be satisfied:

Combination 1 (C1): A1 “+” M1 “+” R1

Combination 2 (C2): A2 “+” M2 “+” R1

Where A, M and R refer to groups of partial factors relating to actions, materials and resistance respectively.

**Table 5.2. Partial Factors Applied to the Bearing Resistance Analysis**

|                                                             | Combination 1 |      |      | Combination 2 |      |      |
|-------------------------------------------------------------|---------------|------|------|---------------|------|------|
|                                                             | A1            | M1   | R1   | A2            | M2   | R2   |
| Tangent of the Angle of Shearing Resistance ( $\tan \phi$ ) |               | 1.00 |      |               | 1.25 |      |
| Cohesion Intercept ( $c'$ )                                 |               | 1.00 |      |               | 1.25 |      |
| Undrained Cohesion $c_u$                                    |               | 1.00 |      |               | 1.40 |      |
| Permanent Action                                            | 1.35          |      |      | 1.00          |      |      |
| Variable Action                                             | 1.50          |      |      | 1.35          |      |      |
| Resistance                                                  |               |      | 1.00 |               |      | 1.00 |

Details of the ground model and the characteristic geotechnical parameters used in the foundation design are presented in Table 5.3.

**Table 5.3. Ground model and characteristic geotechnical parameters**

| Stratum                    | Unit Weight ( $\gamma_k$ )    | Shear Strength                   |                    |                                |                  | Sources           |
|----------------------------|-------------------------------|----------------------------------|--------------------|--------------------------------|------------------|-------------------|
|                            |                               | Undrained                        |                    | Effective                      |                  |                   |
|                            |                               | $c_{uk}$<br>(kN/m <sup>2</sup> ) | $\phi_{uk}$<br>(°) | $c'_k$<br>(kN/m <sup>2</sup> ) | $\phi'_k$<br>(°) |                   |
| From Existing Ground Level |                               |                                  |                    |                                |                  |                   |
| Made Ground                | Not used in foundation design |                                  |                    |                                |                  |                   |
| From 1.00mbgl to 5.00mbgl  |                               |                                  |                    |                                |                  |                   |
| London Clay Formation      | 19kN/m <sup>3</sup>           | 60kN/m <sup>2</sup>              | 0°                 | 0                              | 22°              | $\gamma_k$ BS8004 |
|                            |                               |                                  |                    |                                |                  | $c_{uk}$ SPT N    |
|                            |                               |                                  |                    |                                |                  | $\phi'_k$ BS8004  |
| Groundwater at 1.00mbgl    |                               |                                  |                    |                                |                  |                   |

No structural loads have been provided by the Client; therefore, initially the ULS bearing resistances of a 0.60 and 1.00m wide strip foundations will be assessed.

**Table 5.4. Summary of ULS bearing resistance checks**

| Foundation Depth (mbegl)                       | Foundation Width (m) | Founding Stratum | DA1 Com | ULS Bearing Resistance (kN/m <sup>2</sup> ) |         | ULS Foundation Line Resistance (kN/m) |
|------------------------------------------------|----------------------|------------------|---------|---------------------------------------------|---------|---------------------------------------|
|                                                |                      |                  |         | Undrained                                   | Drained |                                       |
| Minimum depth in accordance with NHBC Guidance |                      |                  |         |                                             |         |                                       |
| Strip Foundation                               |                      |                  |         |                                             |         |                                       |
| 1.00                                           | 0.60                 | LCF              | C1      | 526                                         | 165     | 100                                   |
|                                                |                      |                  | C2      | 381                                         | 107     | 65                                    |
|                                                | 1.00                 | LCF              | C1      | 477                                         | 175     | 175                                   |
|                                                |                      |                  | C2      | 346                                         | 112     | 112                                   |

The ULS bearing resistances presented in Table 5.4 represent the maximum load that can be applied to the soil without failure occurring within the soil mass. As can be seen, increasing the width of the foundation will increase the ULS bearing resistance and also increase the ULS line load that can be supported by the foundation.

However, adoption of these ULS bearing resistances may lead to unacceptable settlement. Therefore, in order to determine the allowable bearing pressure that can be applied to the ground an SLS bearing resistance needs to be defined.

### 5.2.3. Serviceability Limit State

Eurocode 7 states that calculations of settlement must always be carried out on footings on soft clays - and should be carried out on footings on firm to stiff clays when the risk is anything other than negligible. Therefore, in strict accordance with EC7 a full SLS settlement analysis has been undertaken.

Verification of serviceability limit state (SLS) is demonstrated by satisfying the inequality:

$$s_{Ed} = s_0 \leq s_{Cd}$$

where  $s_{Ed}$  is the total settlement; and

$s_{Cd}$  is the limiting value of that settlement

A limiting value of settlement ( $s_{Cd}$ ) of 25mm is considered appropriate for the type of construction under consideration.

Settlement analyses have been carried out on both 0.60m and 1.00m wide strip foundations at 1.00mbgl initially loaded to their ULS bearing pressures of 107 and 112kN/m<sup>2</sup> respectively (Table 5.4).

The settlement analyses have been carried out using the Rockscience software programme Settle 3D. A return has been included in the analysis of the strip foundation as this ensures the greatest amount of settlement is calculated.

The settlement worksheets are located in Appendix 4 of this Report and précised in Table 5.5.

**Table 5.5. Results of the settlement analyses**

| Founding Stratum                         | Depth (mbgl) | Foundation Width (m) | Applied Foundation Loading (kN/m <sup>2</sup> ) | Settlement (mm) |               |       |
|------------------------------------------|--------------|----------------------|-------------------------------------------------|-----------------|---------------|-------|
|                                          |              |                      |                                                 | Immediate       | Consolidation | Total |
| Founding Stratum – London Clay Formation |              |                      |                                                 |                 |               |       |
| Strip Foundation                         |              |                      |                                                 |                 |               |       |
| London Clay Formation                    | 1.00         | 0.60m                | 107                                             | 3               | 12            | 15    |
|                                          |              | 1.00m                | 112                                             | 4               | 17            | 21    |

*Note all loads unfactored for Serviceability Limit State analyses*

The results of the SLS settlement analyses indicate that settlements will remain under the SLS limit of 25mm for both all strip foundations up to 1.00m wide when loaded to their ULS bearing resistances.

For simplicity it is recommended that a allowable bearing pressure of 110kN/m<sup>2</sup> is adopted for all foundations up to 1.00m wide founded in the LCF at a minimum depth of 1.00mbgl.

### 5.3 OTHER GEOTECHNICAL CONSIDERATIONS

#### 5.3.1. Floor Slabs

The thickness of Made Ground and the high volume change potential of the London Clay Formation means a suspended floor slab option should be adopted. Minimum void spaces below suspended floors are presented in Table 7 of the NHBC Guide 2020, reproduced below as Table 5.6.

**Table 5.6 Void dimensions (from NHBC 2020)**

| Volume change Potential | Void dimension against side of foundation and ground beam | Void dimensions under ground beams and suspended in- situ concrete ground floor | Void dimension under suspended precast concrete and timber floors <sup>(1)</sup> |
|-------------------------|-----------------------------------------------------------|---------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| High                    | 35mm                                                      | 150mm                                                                           | 300mm                                                                            |

#### 5.3.2. Excavation Stability

Based on the descriptions of the materials encountered during the ground investigation, foundation excavations should remain stable in the medium term, due to their cohesive nature, especially above any groundwater.

However, in line with good engineering practice, all foundation excavations should remain open for the minimum time possible prior to the placement of foundation concrete. If it becomes apparent that there will be a delay between excavation and placement of concrete, it is recommended that foundation excavations are left short to avoid deterioration of the founding stratum.

### 5.4 CHEMICAL ATTACK ON BURIED CONCRETE

Laboratory chemical testing of pH and sulphate concentrations were undertaken on samples of the MG and LCF. Based on the results of these tests a Design Sulphate class of DS-4 and ACEC classification of AC-3s is considered appropriate for foundation concrete.

## **6. CONCLUSIONS AND RECOMMENDATIONS**

### **6.1 GEOTECHNICAL**

The ground investigation revealed the site to be underlain by Made Ground overlying London Clay Formation to the full depth of the ground investigation.

Groundwater was encountered during the ground investigation at the interface between the Made Ground and underlying London Clay Formation. The groundwater level has been placed at 1.00mbgl for foundation design purposes.

### **6.2 SHALLOW FOUNDATIONS**

Based on the ground conditions encountered at the site a shallow foundation is considered the most appropriate foundation solution.

#### **6.2.1. Foundation Depths**

All foundations should be constructed within the London Clay Formation, which was shown to be of high volume change potential. Therefore, based on NHBC Guidance a minimum foundation depth of 1.00m is required away from the influence of any existing or recently removed trees or other vegetation (Chart 3, Chapter 4.2, NHBC 2020). However, given the thickness of the Made Ground encountered during the ground investigation, it is this rather than the NHBC Guidance that is likely to control the required depth of foundations.

#### **6.2.2. Bearing Resistance**

A ULS bearing resistance analysis has been carried out to determine the ULS bearing resistance of a strip foundation constructed at a minimum of depth of 1.00mbgl. The ULS bearing resistance calculations indicate ULS bearing resistances of 107 and 112kN/m<sup>2</sup> are appropriate for a 0.60 and 1.00m wide strip foundation respectively.

Serviceability limit state settlement analyses have been carried out on these two foundation configurations. The effect of increasing the width of the foundation has been considered and the results show that for all foundation widths up to 1.00m, strip foundations loaded to an allowable bearing resistance of 110kN/m<sup>2</sup> will undergo less than 25mm settlement.

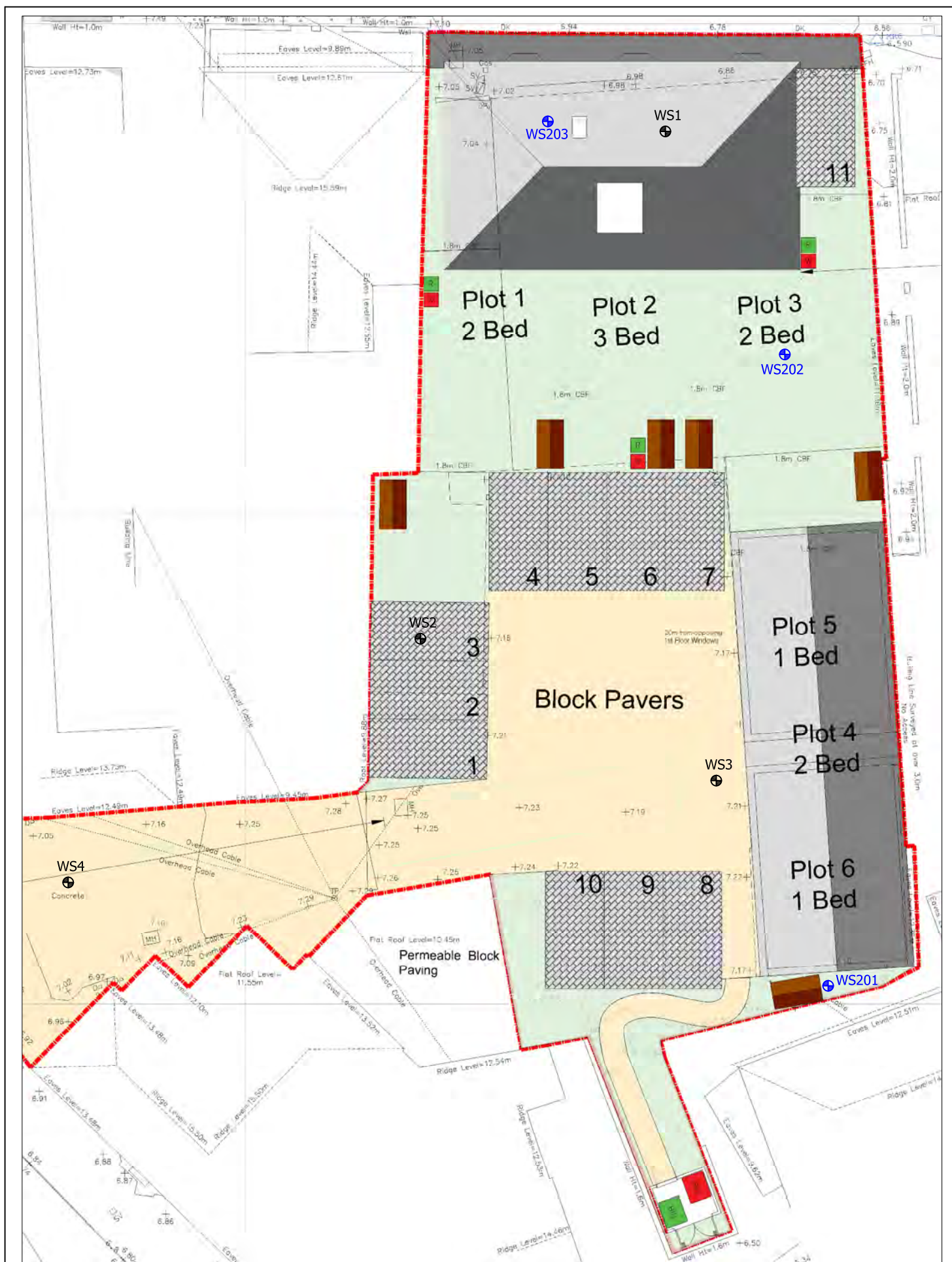
### **6.3 GROUND FLOOR SLABS**

A ground bearing ground floor slab is not considered appropriate due to the presence of the Made Ground and the high volume change potential of the London Clay Formation.

#### 6.4 CONCRETE AGGRESSIVITY

Chemical tests carried out on both the Made Ground and the London Clay Formation show them to be consistent with Design Sulphate Class 4. Based on the assumed static groundwater conditions in the fine-grained London Clay Formation, an ACEC classification of AC-3s should be adopted for all sub-surface concrete.

**FIGURE 1: INVESTIGATION LOCATION PLAN**



**Ground Condition Consultants Ltd**  
10 Wakegrave Close Southampton SO19 9RY  
Telephone 07971 450113  
ask@groundcc.co.uk www.groundcc.co.uk

client **PARCHOW GROUNDWORKS LTD**

site **NORTH STREET, EMSWORTH**

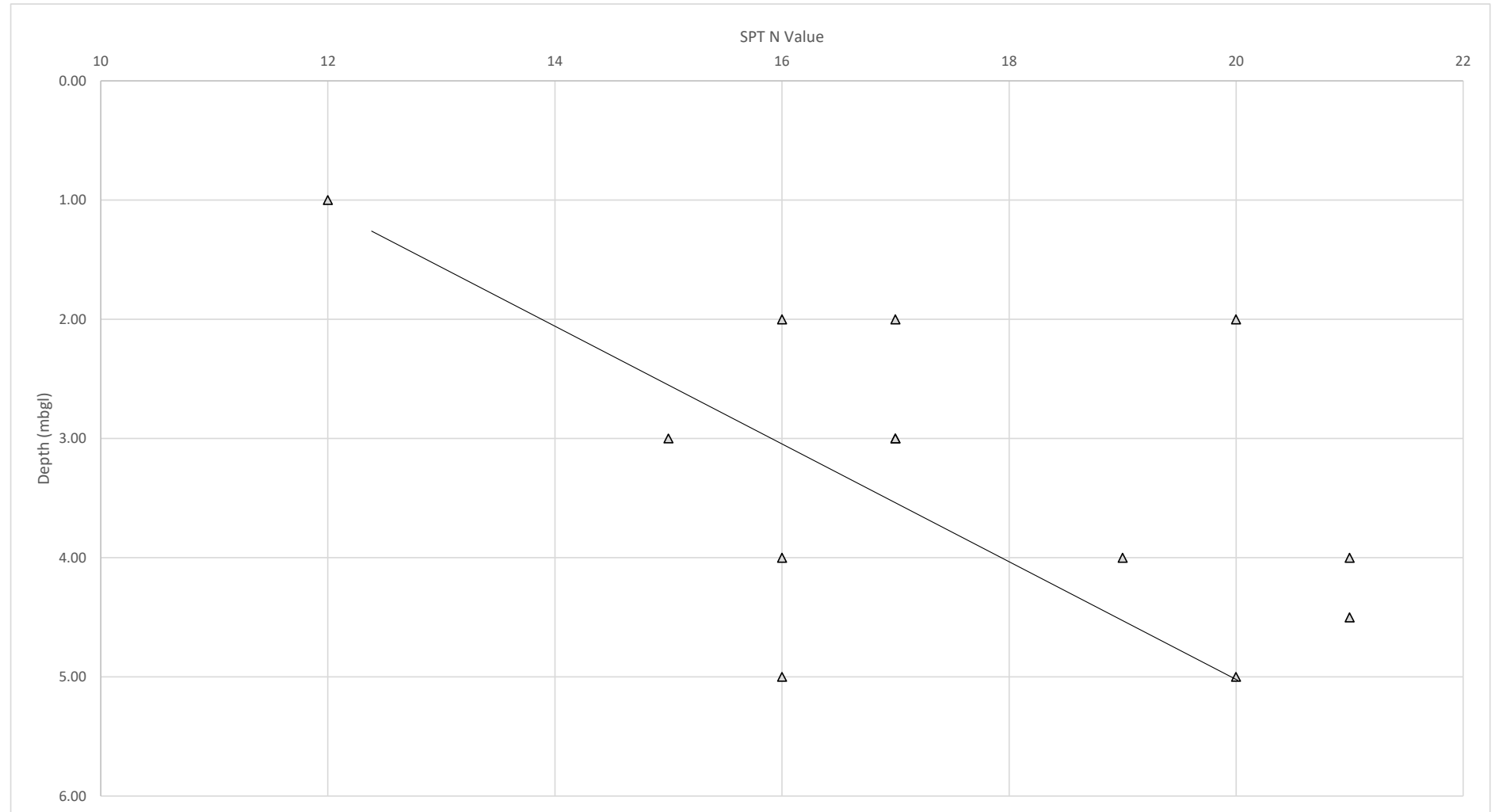
title **SITE INVESTIGATION PLAN**

scale **NTS** drawn by **AP** checked by **RP**

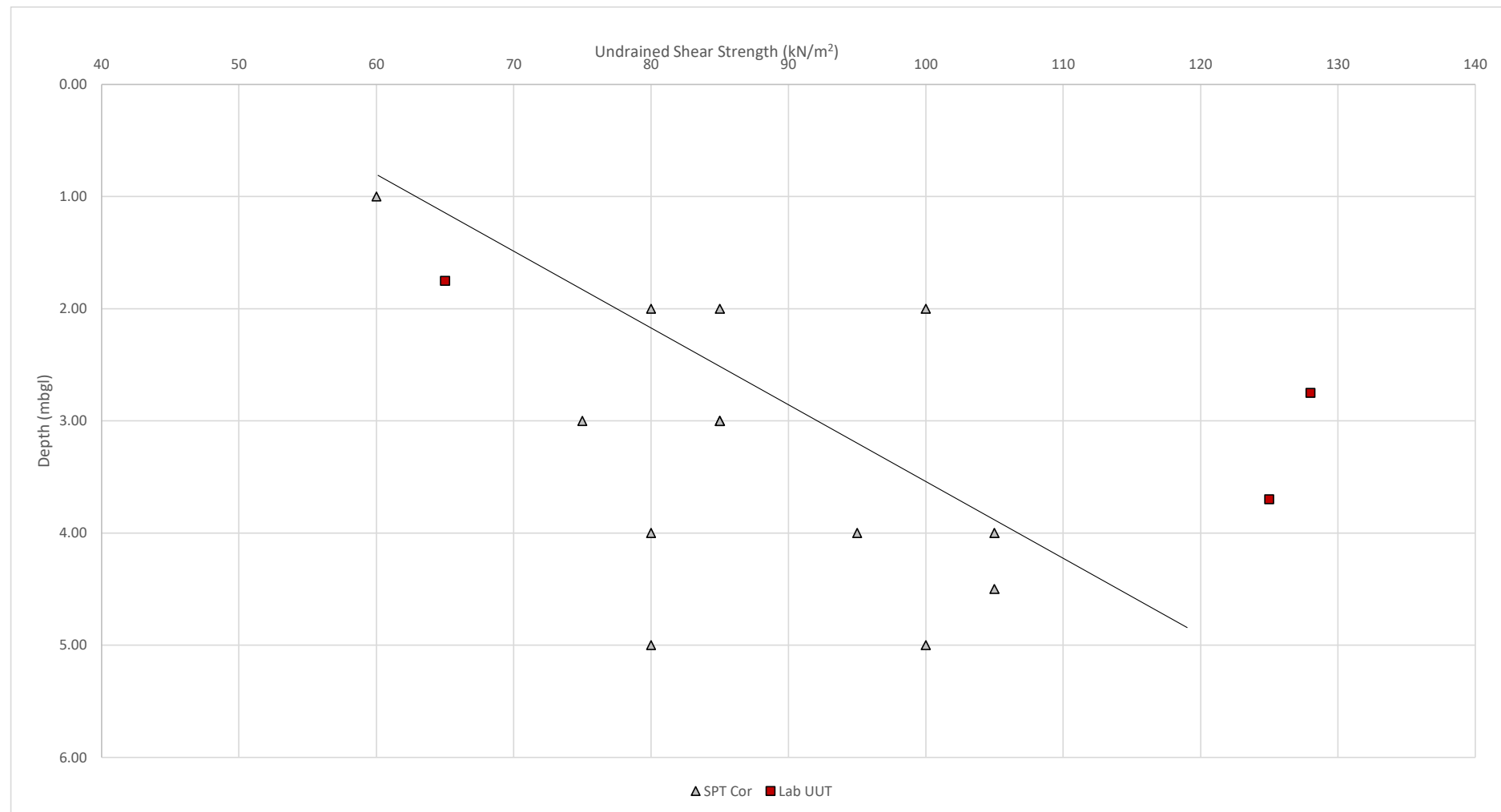
date **14 FEB 2022** job no **J22-014**

drawing number **FIGURE 2** rev. **-**

**FIGURE 2: SPT V DEPTH**



**FIGURE 3: UNDRAINED SHEAR STRENGTH V DEPTH**



## **APPENDIX 1: REPORT CONDITIONS**

This report is produced solely for the benefit of **Parchow Groundworks Ltd** and no liability is accepted for any reliance placed on it by any other party unless specifically agreed in writing otherwise.

This report refers, within the limitations stated, to the condition of the Site at the time of the inspections. No warranty is given as to the possibility of future changes in the condition of the Site.

This report is based on a visual Site inspection, study of readily accessible referenced historical records, information supplied by those parties noted in the text and preliminary discussions with local and Statutory Authorities. Some of the opinions are based on unconfirmed data and information and are presented in good faith without exhaustive clarification. Where ground contamination is suspected but no physical Site test results are available to confirm this, the report must be regarded as initial advice only, and further assessment should be undertaken prior to detailed activities related to the Site. Where test results undertaken by others have been made available these can only be regarded as a limited sample. The possibility of the presence of contaminants, not revealed by this research cannot be discounted.

Whilst confident in the findings detailed within this report because there are no exact UK definitions of these matters, being subject to risk analysis, we are unable to give categorical assurances that they will be accepted by Authorities or Funds etc. without question, as such bodies may have unpublished, often more stringent objectives. This report is prepared for the proposed uses stated in the report and should not be used in a different context without reference to Ground Condition Consultants Ltd. In time improved practices or amended legislation may necessitate a re-assessment.

The report is necessarily limited to those aspects of land contamination specifically reported on and no liability is accepted for any other aspect especially concerning gradual or sudden pollution incidents that may occur. The opinions expressed cannot be absolute due to the limitations of time and resources within the context of the agreed brief and the possibility of unrecorded previous use and abuse of the Site and adjacent Sites. The report concentrates on the Site as defined in the report and provides an opinion on surrounding Sites. If migrating pollution or contamination (past or present) exists this can only practically be better assessed following extensive on and off-site intrusive investigations and monitoring.

**APPENDIX 2: ENGINEERING LOGS**

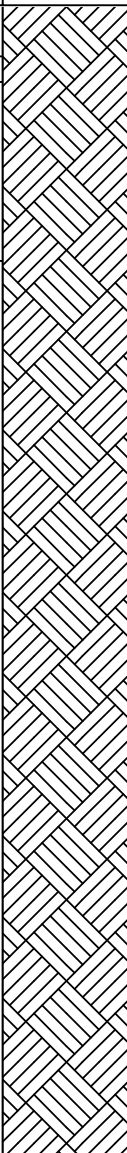
## BOREHOLE LOG WS201

**PROJECT NUMBER** J22-014  
**PROJECT NAME** North Street  
**CLIENT** Parchow Groundworks Ltd  
**ADDRESS** Emsworth  
**DATE** 11/02/22

**DRILLING COMPANY** South Coast Drilling  
**DRILLING METHOD** Windowless Sampling  
**DRILLING RIG** Terrier Mk2  
**LOGGED BY** RP

### CASING

**COMMENTS** No groundwater encountered during drilling

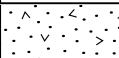
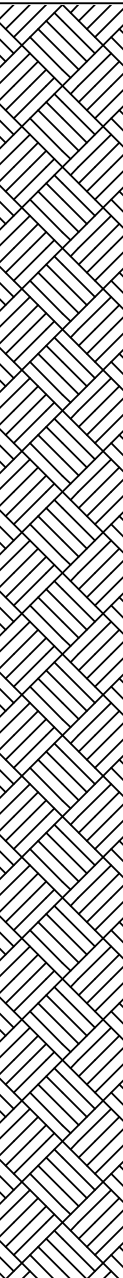
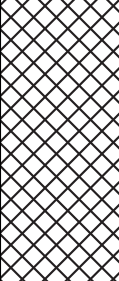
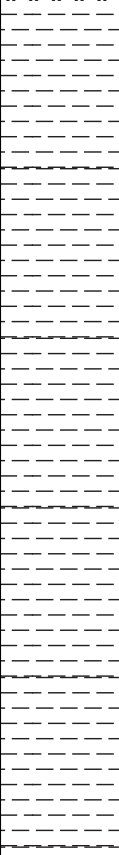
| Samples     | SPT N                          | Water | Depth (m) | Graphic Log | Material Description                                                                                                               | Well Installation                                                                    |
|-------------|--------------------------------|-------|-----------|-------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
|             |                                |       |           |             | Concrete                                                                                                                           |  |
|             |                                |       | 0.2       |             |                                                                                                                                    |                                                                                      |
| B - 0.3-0.5 |                                |       | 0.4       |             | Grey silty clayey SAND with frequent brick fragments (Made Ground)                                                                 |                                                                                      |
|             |                                |       | 0.6       |             | Soft dark grey silty gravelly CLAY with frequent brick fragments. Gravel is fine to coarse angular to rounded flint. (Made Ground) |                                                                                      |
|             |                                |       | 0.8       |             |                                                                                                                                    |                                                                                      |
|             | N=12<br>(2,2,2,3,4,3)          |       | 1         |             |                                                                                                                                    |                                                                                      |
|             |                                |       | 1.2       |             |                                                                                                                                    |                                                                                      |
|             |                                |       | 1.4       |             | Firm to stiff grey mottled brown CLAY with occasional sand pockets and mudstone gravel                                             |                                                                                      |
| L - 1.5-2.0 |                                |       | 1.6       |             |                                                                                                                                    |                                                                                      |
|             |                                |       | 1.8       |             |                                                                                                                                    |                                                                                      |
|             | N=20<br>(2,3,4,5,6,5)          |       | 2         |             |                                                                                                                                    |                                                                                      |
|             |                                |       | 2.2       |             |                                                                                                                                    |                                                                                      |
|             |                                |       | 2.4       |             |                                                                                                                                    |                                                                                      |
| L - 2.5-3.0 |                                |       | 2.6       |             |                                                                                                                                    |                                                                                      |
|             |                                |       | 2.8       |             |                                                                                                                                    |                                                                                      |
|             | N=17<br>(2,3,3,4,4,6)          |       | 3         |             |                                                                                                                                    |                                                                                      |
|             |                                |       | 3.2       |             |                                                                                                                                    |                                                                                      |
|             |                                |       | 3.4       |             |                                                                                                                                    |                                                                                      |
| L - 3.5-4.0 |                                |       | 3.6       |             |                                                                                                                                    |                                                                                      |
|             |                                |       | 3.8       |             |                                                                                                                                    |                                                                                      |
|             | N=19<br>(2,4,4,4,5,6)          |       | 4         |             |                                                                                                                                    |                                                                                      |
|             |                                |       | 4.2       |             |                                                                                                                                    |                                                                                      |
| L - 4.0-4.5 |                                |       | 4.4       |             |                                                                                                                                    |                                                                                      |
|             | N=21<br>(16,9=30mm<br>7,5,4,5) |       |           |             |                                                                                                                                    |                                                                                      |
|             |                                |       | 4.6       |             | Termination Depth at: 4.5m                                                                                                         |                                                                                      |
|             |                                |       | 4.8       |             |                                                                                                                                    |                                                                                      |
|             |                                |       | 5         |             |                                                                                                                                    |                                                                                      |
|             |                                |       | 5.2       |             |                                                                                                                                    |                                                                                      |
|             |                                |       | 5.4       |             |                                                                                                                                    |                                                                                      |

## BOREHOLE LOG WS202

|                                       |                                              |
|---------------------------------------|----------------------------------------------|
| <b>PROJECT NUMBER</b> J22-014         | <b>DRILLING COMPANY</b> South Coast Drilling |
| <b>PROJECT NAME</b> North Street      | <b>DRILLING METHOD</b> Windowless Sampling   |
| <b>CLIENT</b> Parchow Groundworks Ltd | <b>DRILLING RIG</b> Terrier Mk2              |
| <b>ADDRESS</b> Emsworth               | <b>LOGGED BY</b> RP                          |
| <b>DATE</b> 11/02/22                  |                                              |

### CASING

### COMMENTS

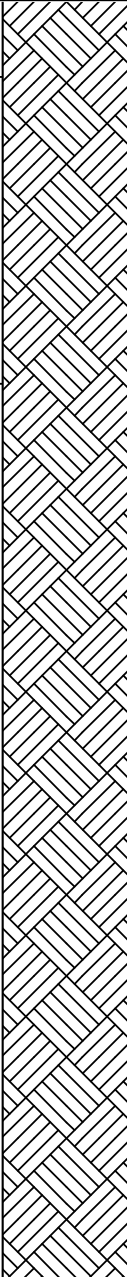
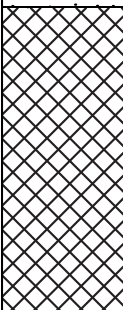
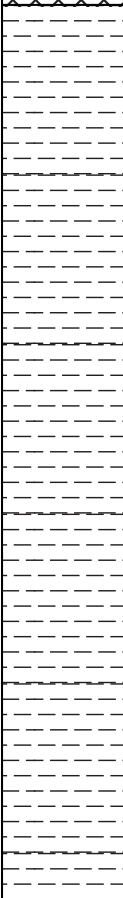
| Samples     | SPT N | Water | Depth (m) | Graphic Log                                                                         | Material Description                                                                                                               | Well Installation                                                                    |
|-------------|-------|-------|-----------|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
|             |       |       | 0.2       |    | Concrete                                                                                                                           |  |
|             |       |       | 0.4       |    | Terracotta floor tiles (Made Ground)                                                                                               |                                                                                      |
| B - 0.5-1.0 |       |       | 0.6       |   | Soft dark grey silty gravelly CLAY with frequent brick fragments. Gravel is fine to coarse angular to rounded flint. (Made Ground) |                                                                                      |
|             |       |       | 0.8       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |       |       | 1         |                                                                                     |                                                                                                                                    |                                                                                      |
|             |       |       | 1.2       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |       |       | 1.4       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |       |       | 1.6       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |       |       | 1.8       |                                                                                     |                                                                                                                                    |                                                                                      |
| L - 1.6-2.0 |       | ∇     | 2         |  | Firm to stiff grey mottled brown CLAY with occasional sand pockets and mudstone gravel                                             |                                                                                      |
|             |       |       | 2.2       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |       |       | 2.4       |                                                                                     |                                                                                                                                    |                                                                                      |
| L - 2.5-3.0 |       |       | 2.6       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |       |       | 2.8       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |       |       | 3         |                                                                                     |                                                                                                                                    |                                                                                      |
|             |       |       | 3.2       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |       |       | 3.4       |                                                                                     |                                                                                                                                    |                                                                                      |
| L - 3.5-4.0 |       |       | 3.6       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |       |       | 3.8       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |       |       | 4         |                                                                                     |                                                                                                                                    |                                                                                      |
|             |       |       | 4.2       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |       |       | 4.4       |                                                                                     |                                                                                                                                    |                                                                                      |
| L - 4.5-5.0 |       |       | 4.6       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |       |       | 4.8       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |       | 5     |           |                                                                                     |                                                                                                                                    |                                                                                      |
|             |       |       | 5.2       | Termination Depth at: 5.0m                                                          |                                                                                                                                    |                                                                                      |
|             |       |       | 5.4       |                                                                                     |                                                                                                                                    |                                                                                      |

## BOREHOLE LOG WS203

|                                                                                                                                                               |                                                                                                                                                      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>PROJECT NUMBER</b> J22-014<br><b>PROJECT NAME</b> North Street<br><b>CLIENT</b> Parchow Groundworks Ltd<br><b>ADDRESS</b> Emsworth<br><b>DATE</b> 11/02/22 | <b>DRILLING COMPANY</b> South Coast Drilling<br><b>DRILLING METHOD</b> Windowless Sampling<br><b>DRILLING RIG</b> Terrier Mk2<br><b>LOGGED BY</b> RP |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|

### CASING

### COMMENTS

| Samples     | SPT N                             | Water | Depth (m) | Graphic Log                                                                         | Material Description                                                                                                               | Well Installation                                                                    |
|-------------|-----------------------------------|-------|-----------|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
|             |                                   |       | 0.2       |    | Concrete                                                                                                                           |  |
| B - 0.5-1.0 |                                   |       | 0.4       |   | Soft dark grey silty gravelly CLAY with frequent brick fragments. Gravel is fine to coarse angular to rounded flint. (Made Ground) |                                                                                      |
|             |                                   |       | 0.6       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |                                   |       | 0.8       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |                                   |       | 1         |                                                                                     |                                                                                                                                    |                                                                                      |
|             | <div>N=13<br/>(1,2,2,3,3,5)</div> | ▽     | 1.2       |  | Firm to stiff grey mottled brown CLAY with occasional sand pockets and mudstone gravel                                             |                                                                                      |
|             |                                   |       | 1.4       |                                                                                     |                                                                                                                                    |                                                                                      |
| L - 1.5-2.0 |                                   |       | 1.6       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |                                   |       | 1.8       |                                                                                     |                                                                                                                                    |                                                                                      |
|             | <div>N=16<br/>(2,2,3,4,4,5)</div> |       | 2         |                                                                                     |                                                                                                                                    |                                                                                      |
|             |                                   |       | 2.2       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |                                   |       | 2.4       |                                                                                     |                                                                                                                                    |                                                                                      |
| L - 2.5-3.0 |                                   |       | 2.6       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |                                   |       | 2.8       |                                                                                     |                                                                                                                                    |                                                                                      |
|             | <div>N=17<br/>(2,3,3,4,4,6)</div> |       | 3         |                                                                                     |                                                                                                                                    |                                                                                      |
|             |                                   |       | 3.2       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |                                   |       | 3.4       |                                                                                     |                                                                                                                                    |                                                                                      |
| L - 3.5-4.0 |                                   |       | 3.6       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |                                   |       | 3.8       |                                                                                     |                                                                                                                                    |                                                                                      |
|             | <div>N=21<br/>(3,3,5,4,6,6)</div> |       | 4         |                                                                                     |                                                                                                                                    |                                                                                      |
|             |                                   |       | 4.2       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |                                   |       | 4.4       |                                                                                     |                                                                                                                                    |                                                                                      |
| L - 4.5-5.0 |                                   |       | 4.6       |                                                                                     |                                                                                                                                    |                                                                                      |
|             |                                   |       | 4.8       |                                                                                     |                                                                                                                                    |                                                                                      |
|             | <div>N=20<br/>(2,3,4,5,5,6)</div> |       | 5         |                                                                                     |                                                                                                                                    |                                                                                      |
|             |                                   | 5.2   |           | Termination Depth at: 5.0m                                                          |                                                                                                                                    |                                                                                      |
|             |                                   | 5.4   |           |                                                                                     |                                                                                                                                    |                                                                                      |

### **APPENDIX 3: GEOTECHNICAL TEST CERTIFICATES**

# TEST CERTIFICATE

## DETERMINATION OF LIQUID AND PLASTIC LIMITS

Tested in Accordance with: BS 1377-2:1990: Clause 4.4 and 5

i2 Analytical Ltd  
Unit 8 Harrowden Road  
Brackmills Industrial Estate  
Northampton NN4 7EB

Client: Ground Condition Consultants  
Client Address: 10 Waldegrave Close, Southampton,  
S019 9RY

Contact: Antony Platt  
Site Address: North Street, Emsworth

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Client Reference: J22-014  
Job Number: 22-40198  
Date Sampled: Not Given  
Date Received: 14/02/2022  
Date Tested: 03/03/2022  
Sampled By: Not Given

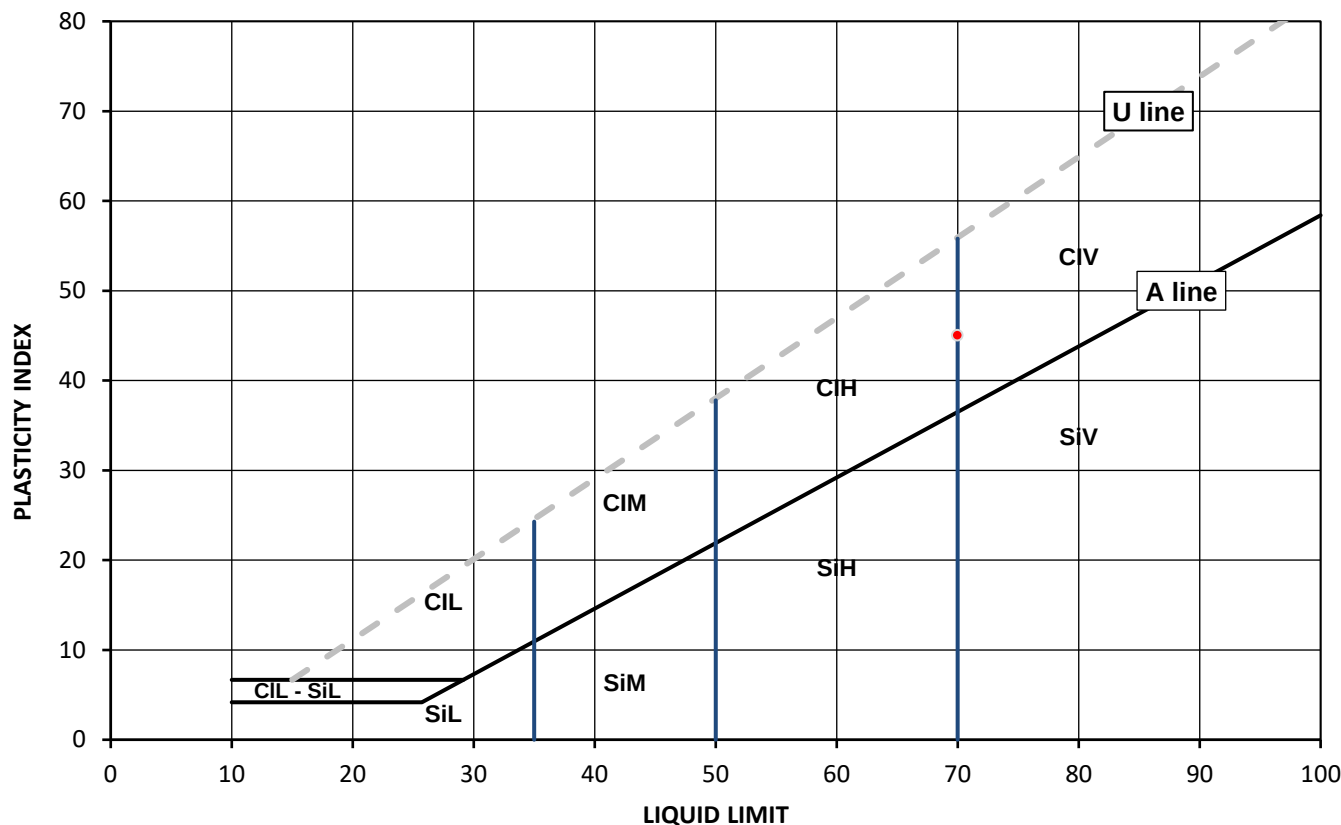
### Test Results:

Laboratory Reference: 2175664  
Hole No.: WS201  
Sample Reference: Not Given  
Sample Description: Yellowish brown slightly gravelly CLAY

Depth Top [m]: 1.50  
Depth Base [m]: 2.00  
Sample Type: L

Sample Preparation: Tested after washing to remove >425um

| As Received Water Content [ W ] % | Liquid Limit [ WL ] % | Plastic Limit [ Wp ] % | Plasticity Index [ Ip ] % | % Passing 425µm BS Test Sieve |
|-----------------------------------|-----------------------|------------------------|---------------------------|-------------------------------|
| 27                                | 70                    | 25                     | 45                        | 95                            |



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

|    | Plasticity  | Liquid Limit                                              |
|----|-------------|-----------------------------------------------------------|
| Cl | Clay        | below 35                                                  |
| Si | Silt        | 35 to 50                                                  |
|    | L Low       | 50 to 70                                                  |
|    | M Medium    | exceeding 70                                              |
|    | H High      | append to classification for organic material ( eg CIHO ) |
|    | V Very high |                                                           |
|    | O Organic   |                                                           |

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Signed:

Anna Dudzinska  
Deputy Head of Geo Office Section  
for and on behalf of i2 Analytical Ltd

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*Dudzinska Anna*

Client: Ground Condition Consultants  
Client Address: 10 Waldegrave Close, Southampton,  
S019 9RY

Contact: Antony Platt  
Site Address: North Street, Emsworth

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Client Reference: J22-014  
Job Number: 22-40198  
Date Sampled: Not Given  
Date Received: 14/02/2022  
Date Tested: 02/03/2022  
Sampled By: Not Given

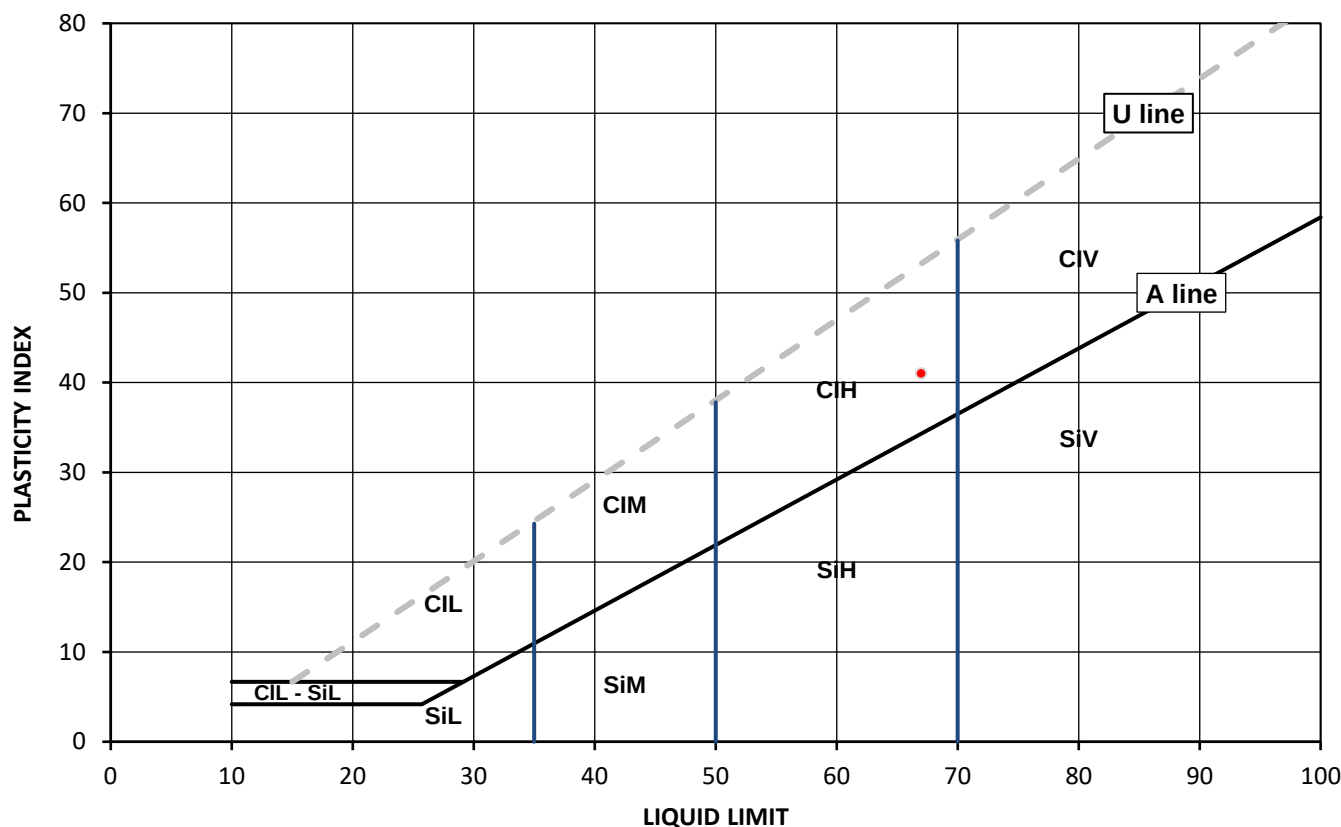
### Test Results:

Laboratory Reference: 2175665  
Hole No.: WS201  
Sample Reference: Not Given  
Sample Description: Brown CLAY

Depth Top [m]: 2.50  
Depth Base [m]: 3.00  
Sample Type: L

Sample Preparation: Tested in natural condition

| As Received Water Content [ W ] % | Liquid Limit [ WL ] % | Plastic Limit [ Wp ] % | Plasticity Index [ Ip ] % | % Passing 425µm BS Test Sieve |
|-----------------------------------|-----------------------|------------------------|---------------------------|-------------------------------|
| 29                                | 67                    | 26                     | 41                        | 100                           |



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

|    |      |            |   |           |              |                                                           |
|----|------|------------|---|-----------|--------------|-----------------------------------------------------------|
| CI | Clay | Plasticity | L | Low       | Liquid Limit | below 35                                                  |
| Si | Silt |            | M | Medium    |              | 35 to 50                                                  |
|    |      |            | H | High      |              | 50 to 70                                                  |
|    |      |            | V | Very high |              | exceeding 70                                              |
|    |      |            | O | Organic   |              | append to classification for organic material ( eg CIHO ) |

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Signed:

Anna Dudzinska  
Deputy Head of Geo Office Section  
for and on behalf of i2 Analytical Ltd

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4041

Client: Ground Condition Consultants  
Client Address: 10 Waldegrave Close, Southampton,  
S019 9RY

Contact: Antony Platt  
Site Address: North Street, Emsworth

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Client Reference: J22-014  
Job Number: 22-40198  
Date Sampled: Not Given  
Date Received: 14/02/2022  
Date Tested: 02/03/2022  
Sampled By: Not Given

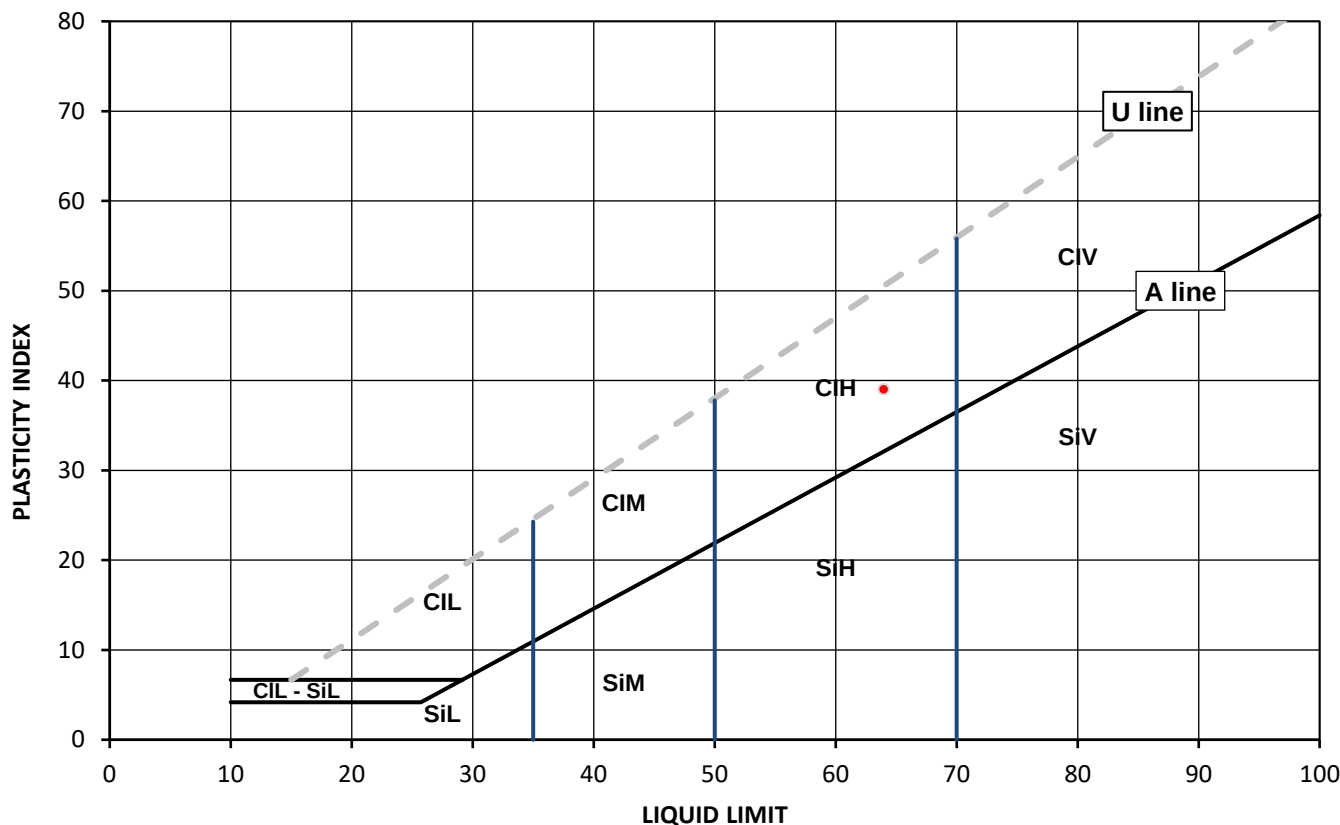
### Test Results:

Laboratory Reference: 2175666  
Hole No.: WS202  
Sample Reference: Not Given  
Sample Description: Brown slightly gravelly CLAY

Depth Top [m]: 1.60  
Depth Base [m]: 2.00  
Sample Type: L

Sample Preparation: Tested after washing to remove >425um

| As Received Water Content [ W ] % | Liquid Limit [ WL ] % | Plastic Limit [ Wp ] % | Plasticity Index [ Ip ] % | % Passing 425µm BS Test Sieve |
|-----------------------------------|-----------------------|------------------------|---------------------------|-------------------------------|
| 24                                | 64                    | 25                     | 39                        | 96                            |



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

|    | Plasticity | Liquid Limit                                              |
|----|------------|-----------------------------------------------------------|
| Cl | Clay       | below 35                                                  |
| Si | Silt       | 35 to 50                                                  |
|    | L          | Low                                                       |
|    | M          | Medium                                                    |
|    | H          | High                                                      |
|    | V          | Very high                                                 |
|    | O          | Organic                                                   |
|    |            | append to classification for organic material ( eg CIHO ) |

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Signed:

Anna Dudzinska  
Deputy Head of Geo Office Section  
for and on behalf of i2 Analytical Ltd

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*Anna Dudzinska*

Client: Ground Condition Consultants  
Client Address: 10 Waldegrave Close, Southampton,  
S019 9RY

Contact: Antony Platt  
Site Address: North Street, Emsworth

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Client Reference: J22-014  
Job Number: 22-40198  
Date Sampled: Not Given  
Date Received: 14/02/2022  
Date Tested: 02/03/2022  
Sampled By: Not Given

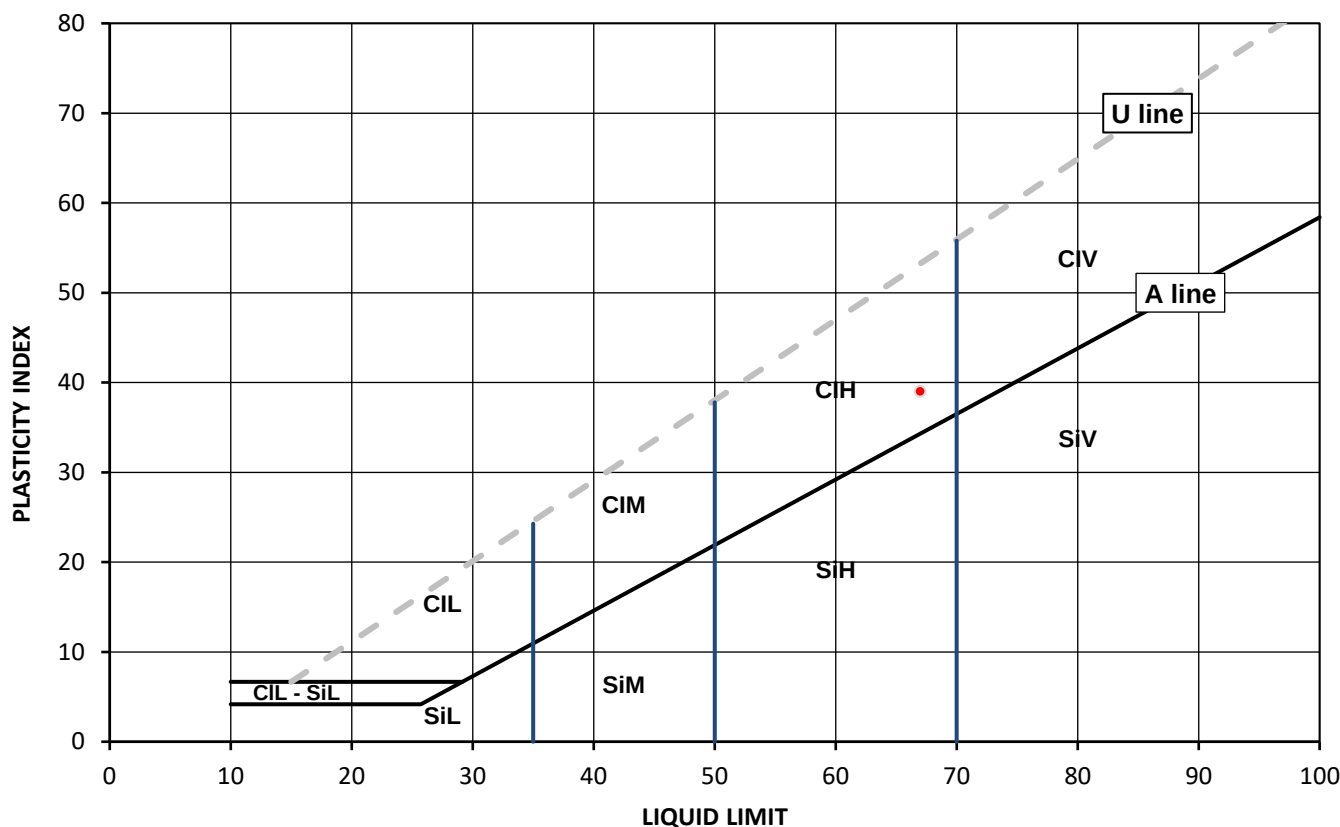
### Test Results:

Laboratory Reference: 2175667  
Hole No.: WS202  
Sample Reference: Not Given  
Sample Description: Brown CLAY

Depth Top [m]: 2.50  
Depth Base [m]: 3.00  
Sample Type: L

Sample Preparation: Tested in natural condition

| As Received Water Content [ W ] % | Liquid Limit [ WL ] % | Plastic Limit [ Wp ] % | Plasticity Index [ Ip ] % | % Passing 425µm BS Test Sieve |
|-----------------------------------|-----------------------|------------------------|---------------------------|-------------------------------|
| 26                                | 67                    | 28                     | 39                        | 100                           |



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

|    |      |            |   |           |              |                                                           |
|----|------|------------|---|-----------|--------------|-----------------------------------------------------------|
| Cl | Clay | Plasticity | L | Low       | Liquid Limit | below 35                                                  |
| Si | Silt |            | M | Medium    |              | 35 to 50                                                  |
|    |      |            | H | High      |              | 50 to 70                                                  |
|    |      |            | V | Very high |              | exceeding 70                                              |
|    |      |            | O | Organic   |              | append to classification for organic material ( eg CIHO ) |

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Signed:

Anna Dudzinska  
Deputy Head of Geo Office Section  
for and on behalf of i2 Analytical Ltd

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*Dudzinska Anna*

# TEST CERTIFICATE

## DETERMINATION OF LIQUID AND PLASTIC LIMITS

Tested in Accordance with: BS 1377-2:1990: Clause 4.4 and 5

i2 Analytical Ltd  
Unit 8 Harrowden Road  
Brackmills Industrial Estate  
Northampton NN4 7EB

Client: Ground Condition Consultants  
Client Address: 10 Waldegrave Close, Southampton,  
S019 9RY

Contact: Antony Platt  
Site Address: North Street, Emsworth

Client Reference: J22-014  
Job Number: 22-40198  
Date Sampled: Not Given  
Date Received: 14/02/2022  
Date Tested: 02/03/2022  
Sampled By: Not Given

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

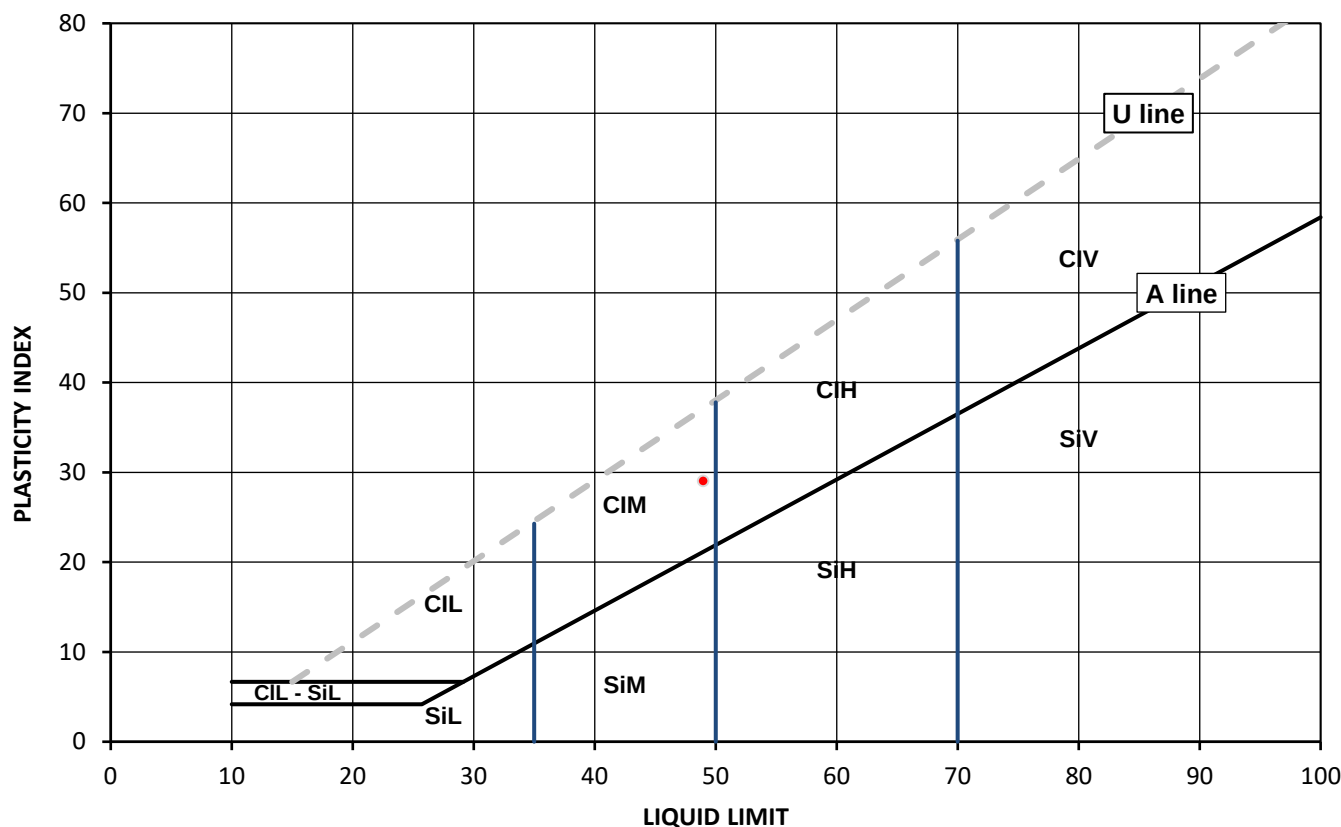
### Test Results:

Laboratory Reference: 2175668  
Hole No.: WS203  
Sample Reference: Not Given  
Sample Description: Yellowish brown gravelly slightly sandy CLAY

Depth Top [m]: 1.50  
Depth Base [m]: 2.00  
Sample Type: L

Sample Preparation: Tested after washing to remove &gt;425um

| As Received Water Content [ W ] % | Liquid Limit [ WL ] % | Plastic Limit [ Wp ] % | Plasticity Index [ Ip ] % | % Passing 425µm BS Test Sieve |
|-----------------------------------|-----------------------|------------------------|---------------------------|-------------------------------|
| 12                                | 49                    | 20                     | 29                        | 62                            |



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

|    |      |            |   |           |              |                                                           |
|----|------|------------|---|-----------|--------------|-----------------------------------------------------------|
| Cl | Clay | Plasticity | L | Low       | Liquid Limit | below 35                                                  |
| Si | Silt |            | M | Medium    |              | 35 to 50                                                  |
|    |      |            | H | High      |              | 50 to 70                                                  |
|    |      |            | V | Very high |              | exceeding 70                                              |
|    |      |            | O | Organic   |              | append to classification for organic material ( eg CIHO ) |

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Signed:

Anna Dudzinska  
Deputy Head of Geo Office Section  
for and on behalf of i2 Analytical Ltd

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4041

Client: Ground Condition Consultants  
Client Address: 10 Waldegrave Close, Southampton,  
S019 9RY

Contact: Antony Platt  
Site Address: North Street, Emsworth

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Client Reference: J22-014  
Job Number: 22-40198  
Date Sampled: Not Given  
Date Received: 14/02/2022  
Date Tested: 02/03/2022  
Sampled By: Not Given

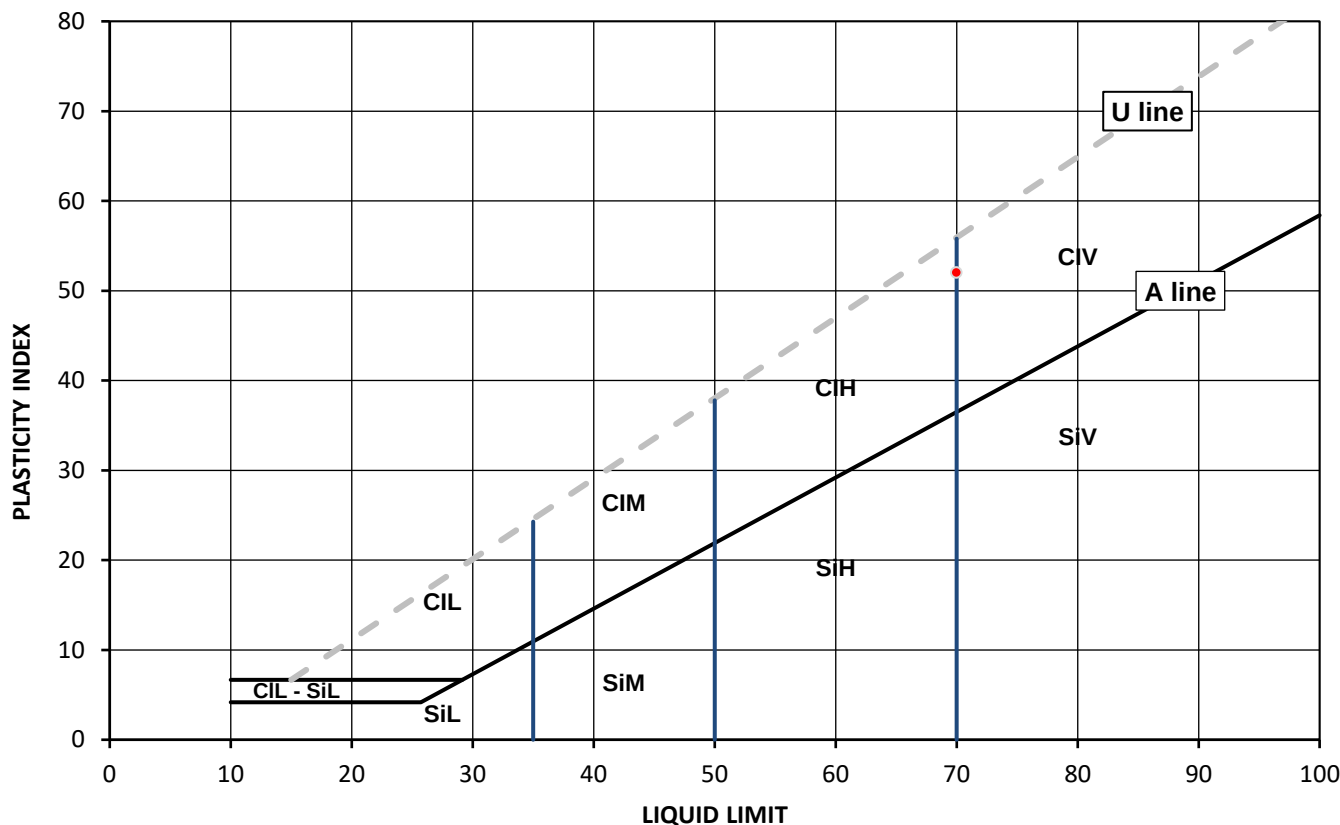
### Test Results:

Laboratory Reference: 2175669  
Hole No.: WS203  
Sample Reference: Not Given  
Sample Description: Brown CLAY

Depth Top [m]: 3.40  
Depth Base [m]: 4.00  
Sample Type: L

Sample Preparation: Tested in natural condition

| As Received Water Content [ W ] % | Liquid Limit [ WL ] % | Plastic Limit [ Wp ] % | Plasticity Index [ Ip ] % | % Passing 425µm BS Test Sieve |
|-----------------------------------|-----------------------|------------------------|---------------------------|-------------------------------|
| 29                                | 70                    | 18                     | 52                        | 100                           |



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

|    | Plasticity  | Liquid Limit                                              |
|----|-------------|-----------------------------------------------------------|
| Cl | Clay        | below 35                                                  |
| Si | Silt        | 35 to 50                                                  |
|    | L Low       | 50 to 70                                                  |
|    | M Medium    | exceeding 70                                              |
|    | H High      |                                                           |
|    | V Very high |                                                           |
|    | O Organic   | append to classification for organic material ( eg CIHO ) |

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Signed:

Anna Dudzinska  
Deputy Head of Geo Office Section  
for and on behalf of i2 Analytical Ltd

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*Dudzinska Anna*



4041

Client: Ground Condition Consultants

Client Address: 10 Waldegrave Close, Southampton,  
S019 9RY

Contact: Antony Platt

Site Address: North Street, Emsworth

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

**SUMMARY REPORT****SUMMARY OF CLASSIFICATION TEST RESULTS**

Tested in Accordance with:

Water Content by BS 1377-2:1990: Clause 3.2; Atterberg by BS 1377-2: 1990:  
Clause 4.3 (4 Point Test), Clause 4.4 (1 Point Test) and 5; PD by BS 1377-2:  
1990: Clause 8.2i2 Analytical Ltd  
Unit 8 Harrowden Road  
Brackmills Industrial Estate  
Northampton NN4 7EB

Environmental Science

Client Reference: J22-014

Job Number: 22-40198

Date Sampled: Not Given

Date Received: 14/02/2022

Date Tested: 02/03 - 03/03/2022

Sampled By: Not Given

**Test results**

| Laboratory Reference | Hole No. | Sample    |                   |                    |      | Description                                  | Remarks           | Water Content<br>BS 1377-2 [ W ]<br>% | Water Content<br>BS EN ISO 17892-1<br>[ W ]<br>% | Atterberg                  |         |         |         | Density       |              |             | Total<br>Porosity#<br>% |  |  |
|----------------------|----------|-----------|-------------------|--------------------|------|----------------------------------------------|-------------------|---------------------------------------|--------------------------------------------------|----------------------------|---------|---------|---------|---------------|--------------|-------------|-------------------------|--|--|
|                      |          | Reference | Depth<br>Top<br>m | Depth<br>Base<br>m | Type |                                              |                   |                                       |                                                  | %<br>Passing<br>425um<br>% | WL<br>% | Wp<br>% | Ip<br>% | bulk<br>Mg/m3 | dry<br>Mg/m3 | PD<br>Mg/m3 |                         |  |  |
| 2175664              | WS201    | Not Given | 1.50              | 2.00               | L    | Yellowish brown slightly gravelly CLAY       | Atterberg 1 Point | 27                                    |                                                  | 95                         | 70      | 25      | 45      |               |              |             |                         |  |  |
| 2175665              | WS201    | Not Given | 2.50              | 3.00               | L    | Brown CLAY                                   | Atterberg 1 Point | 29                                    |                                                  | 100                        | 67      | 26      | 41      |               |              |             |                         |  |  |
| 2175666              | WS202    | Not Given | 1.60              | 2.00               | L    | Brown slightly gravelly CLAY                 | Atterberg 1 Point | 24                                    |                                                  | 96                         | 64      | 25      | 39      |               |              |             |                         |  |  |
| 2175667              | WS202    | Not Given | 2.50              | 3.00               | L    | Brown CLAY                                   | Atterberg 1 Point | 26                                    |                                                  | 100                        | 67      | 28      | 39      |               |              |             |                         |  |  |
| 2175668              | WS203    | Not Given | 1.50              | 2.00               | L    | Yellowish brown gravelly slightly sandy CLAY | Atterberg 1 Point | 12                                    |                                                  | 62                         | 49      | 20      | 29      |               |              |             |                         |  |  |
| 2175669              | WS203    | Not Given | 3.40              | 4.00               | L    | Brown CLAY                                   | Atterberg 1 Point | 29                                    |                                                  | 100                        | 70      | 18      | 52      |               |              |             |                         |  |  |
|                      |          |           |                   |                    |      |                                              |                   |                                       |                                                  |                            |         |         |         |               |              |             |                         |  |  |
|                      |          |           |                   |                    |      |                                              |                   |                                       |                                                  |                            |         |         |         |               |              |             |                         |  |  |
|                      |          |           |                   |                    |      |                                              |                   |                                       |                                                  |                            |         |         |         |               |              |             |                         |  |  |
|                      |          |           |                   |                    |      |                                              |                   |                                       |                                                  |                            |         |         |         |               |              |             |                         |  |  |

Note: # Non accredited; NP - Non plastic

Comments:

Signed:

Anna Dudzinska  
Deputy Head of Geo Office Section  
for and on behalf of i2 Analytical Ltd

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4041

Client: Ground Condition Consultants

Client Address: 10 Waldegrave Close, Southampton,  
S019 9RY

Contact: Antony Platt

Site Address: North Street, Emsworth

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

**SUMMARY REPORT****DETERMINATION OF WATER CONTENT**

Tested in Accordance with: BS 1377-2: 1990: Clause 3.2

i2 Analytical Ltd  
Unit 8 Harrowden Road  
Brackmills Industrial Estate  
Northampton NN4 7EB

Environmental Science

Client Reference: J22-014

Job Number: 22-40198

Date Sampled: Not Given

Date Received: 14/02/2022

Date Tested: 02/03 - 03/03/2022

Sampled By: Not Given

**Test results**

| Laboratory Reference | Hole No. | Sample    |                |                 |      | Description                                  | Remarks | WC | Sample preparation / Oven temperature at the time of testing |  |  |  |
|----------------------|----------|-----------|----------------|-----------------|------|----------------------------------------------|---------|----|--------------------------------------------------------------|--|--|--|
|                      |          | Reference | Depth Top<br>m | Depth Base<br>m | Type |                                              |         |    |                                                              |  |  |  |
| 2175664              | WS201    | Not Given | 1.50           | 2.00            | L    | Yellowish brown slightly gravelly CLAY       |         | 27 | Sample was quartered, oven dried at 108.8 °C                 |  |  |  |
| 2175665              | WS201    | Not Given | 2.50           | 3.00            | L    | Brown CLAY                                   |         | 29 | Sample was quartered, oven dried at 109 °C                   |  |  |  |
| 2175666              | WS202    | Not Given | 1.60           | 2.00            | L    | Brown slightly gravelly CLAY                 |         | 24 | Sample was quartered, oven dried at 109 °C                   |  |  |  |
| 2175667              | WS202    | Not Given | 2.50           | 3.00            | L    | Brown CLAY                                   |         | 26 | Sample was quartered, oven dried at 109 °C                   |  |  |  |
| 2175668              | WS203    | Not Given | 1.50           | 2.00            | L    | Yellowish brown gravelly slightly sandy CLAY |         | 12 | Sample was quartered, oven dried at 109 °C                   |  |  |  |
| 2175669              | WS203    | Not Given | 3.40           | 4.00            | L    | Brown CLAY                                   |         | 29 | Sample was quartered, oven dried at 109 °C                   |  |  |  |
|                      |          |           |                |                 |      |                                              |         |    |                                                              |  |  |  |
|                      |          |           |                |                 |      |                                              |         |    |                                                              |  |  |  |
|                      |          |           |                |                 |      |                                              |         |    |                                                              |  |  |  |
|                      |          |           |                |                 |      |                                              |         |    |                                                              |  |  |  |

Comments:

Signed:

Anna Dudzinska  
Deputy Head of Geo Office Section  
for and on behalf of i2 Analytical Ltd

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# TEST CERTIFICATE

## DETERMINATION OF THE UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE

i2 Analytical Ltd  
Unit 8 Harrowden Road  
Brackmills Industrial Estate  
Northampton NN4 7EB

Tested in Accordance with: BS 1377-7: 1990: Clause 8

Client: Ground Condition Consultants  
Client Address: 10 Waldegrave Close, Southampton,  
S019 9RY

Contact: Antony Platt  
Site Address: North Street, Emsworth

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Client Reference: J22-014  
Job Number: 22-40198  
Date Sampled: Not Given  
Date Received: 14/02/2022  
Date Tested: 03/03/2022  
Sampled By: Not Given

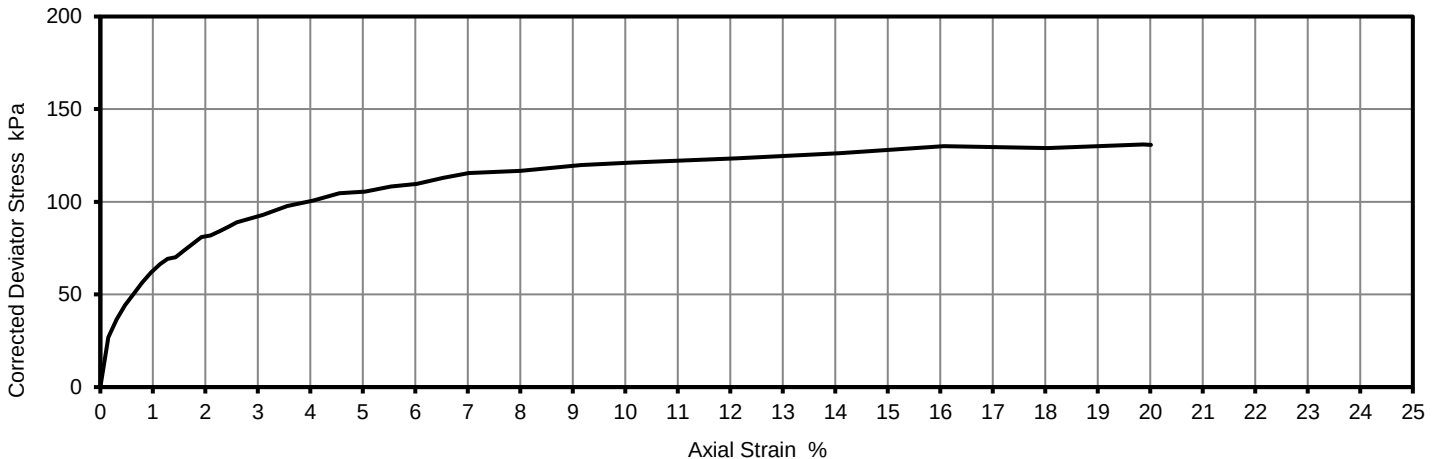
### Test Results:

Laboratory Reference: 2175664  
Hole No.: WS201  
Sample Reference: Not Given  
Sample Description: Yellowish brown slightly gravelly CLAY  
Sample Preparation: Sample prepared in accordance with BS 1377-1:2016 Clause 9.1.1.

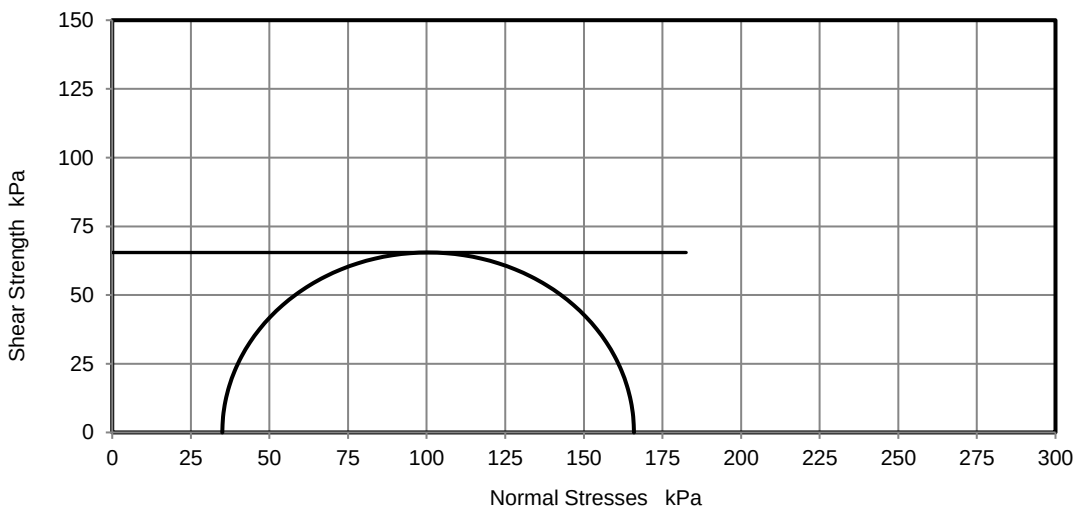
Depth Top [m]: 1.50  
Depth Base [m]: 2.00  
Sample Type: L

|                     |        |                                                         |          |                                          |
|---------------------|--------|---------------------------------------------------------|----------|------------------------------------------|
| Test Number         | 1      | Rate of Strain                                          | 2.00     | %/min                                    |
| Length              | 100.59 | Cell Pressure                                           | 35       | kPa                                      |
| Diameter            | 49.63  | Axial Strain at failure                                 | 19.9     | %                                        |
| Bulk Density        | 1.98   | Deviator Stress, ( $\sigma_1 - \sigma_3$ ) <sub>f</sub> | 131      | kPa                                      |
| Moisture Content    | 27     | Undrained Shear Strength, $c_u$                         | 65       | kPa $\frac{1}{2}(\sigma_1 - \sigma_3)_f$ |
| Dry Density         | 1.56   | Mode of Failure                                         | Compound |                                          |
| Membrane Correction | 1.62   | Membrane thickness                                      | 0.21     | mm                                       |

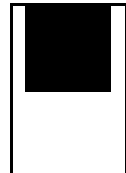
### Deviator Stress v Axial Strain



### Mohr Circles



Position within sample



Note: Deviator stress corrected for area change and membrane effects. Mohr circles and their interpretation is not covered by BS1377.  
This is provided for information only.

### Remarks:

### Signed:

*Anna Dudzinska*

Anna Dudzinska  
Deputy Head of Geo Office Section  
for and on behalf of i2 Analytical Ltd

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# TEST CERTIFICATE

## DETERMINATION OF THE UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE

i2 Analytical Ltd  
Unit 8 Harrowden Road  
Brackmills Industrial Estate  
Northampton NN4 7EB

Tested in Accordance with: BS 1377-7: 1990: Clause 8

Client: Ground Condition Consultants  
Client Address: 10 Waldegrave Close, Southampton,  
S019 9RY

Contact: Antony Platt  
Site Address: North Street, Emsworth

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Client Reference: J22-014  
Job Number: 22-40198  
Date Sampled: Not Given  
Date Received: 14/02/2022  
Date Tested: 02/03/2022  
Sampled By: Not Given

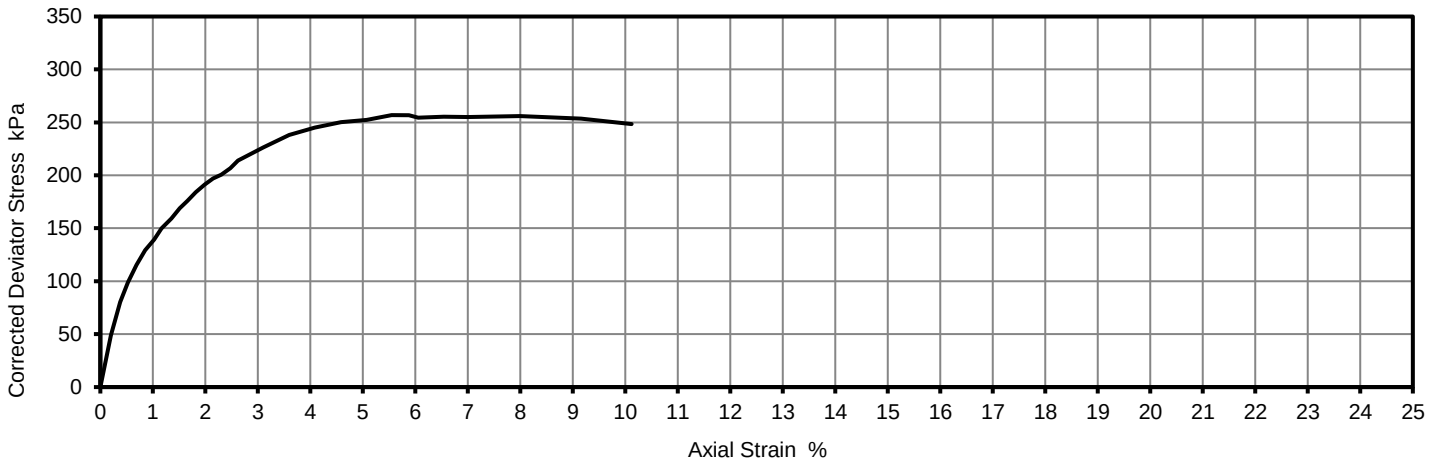
### Test Results:

Laboratory Reference: 2175667  
Hole No.: WS202  
Sample Reference: Not Given  
Sample Description: Brown CLAY  
Sample Preparation: Sample prepared in accordance with BS 1377-1:2016 Clause 9.1.1.

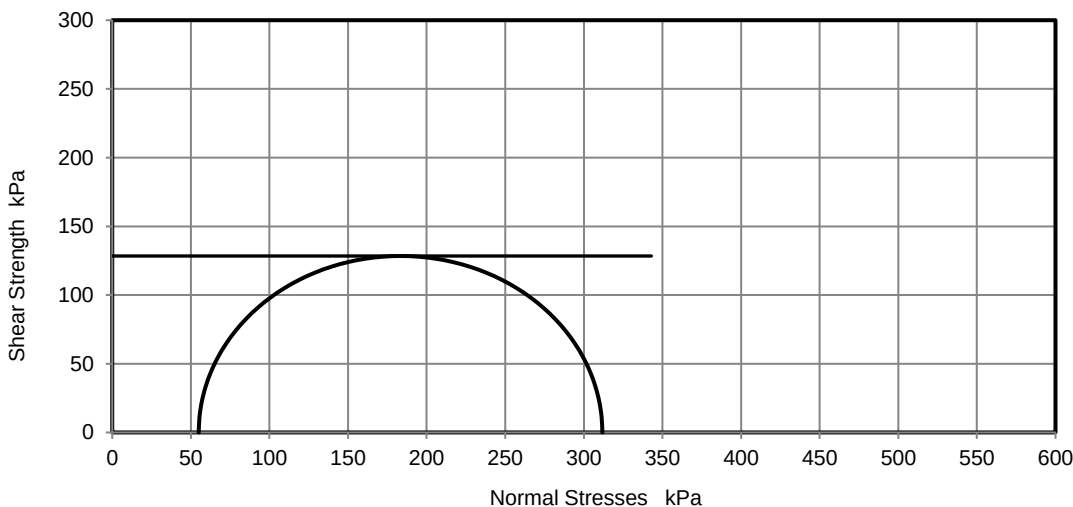
Depth Top [m]: 2.50  
Depth Base [m]: 3.00  
Sample Type: L

|                     |        |                                                         |          |                                          |
|---------------------|--------|---------------------------------------------------------|----------|------------------------------------------|
| Test Number         | 1      | Rate of Strain                                          | 2.00     | %/min                                    |
| Length              | 100.60 | Cell Pressure                                           | 55       | kPa                                      |
| Diameter            | 49.76  | Axial Strain at failure                                 | 5.9      | %                                        |
| Bulk Density        | 1.99   | Deviator Stress, ( $\sigma_1 - \sigma_3$ ) <sub>f</sub> | 257      | kPa                                      |
| Moisture Content    | 26     | Undrained Shear Strength, $c_u$                         | 128      | kPa $\frac{1}{2}(\sigma_1 - \sigma_3)_f$ |
| Dry Density         | 1.58   | Mode of Failure                                         | Compound |                                          |
| Membrane Correction | 0.72   | Membrane thickness                                      | 0.23     | mm                                       |

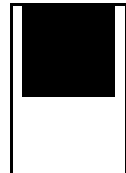
### Deviator Stress v Axial Strain



### Mohr Circles



Position within sample



Note: Deviator stress corrected for area change and membrane effects. Mohr circles and their interpretation is not covered by BS1377.  
This is provided for information only.

### Remarks:

### Signed:

Anna Dudzinska  
Deputy Head of Geo Office Section  
for and on behalf of i2 Analytical Ltd

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*Dudzinska Anna*

# TEST CERTIFICATE

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i2 Analytical Ltd  
Unit 8 Harrowden Road  
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Northampton NN4 7EB

Tested in Accordance with: BS 1377-7: 1990: Clause 8

Client: Ground Condition Consultants  
Client Address: 10 Waldegrave Close, Southampton,  
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Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Client Reference: J22-014  
Job Number: 22-40198  
Date Sampled: Not Given  
Date Received: 14/02/2022  
Date Tested: 02/03/2022  
Sampled By: Not Given

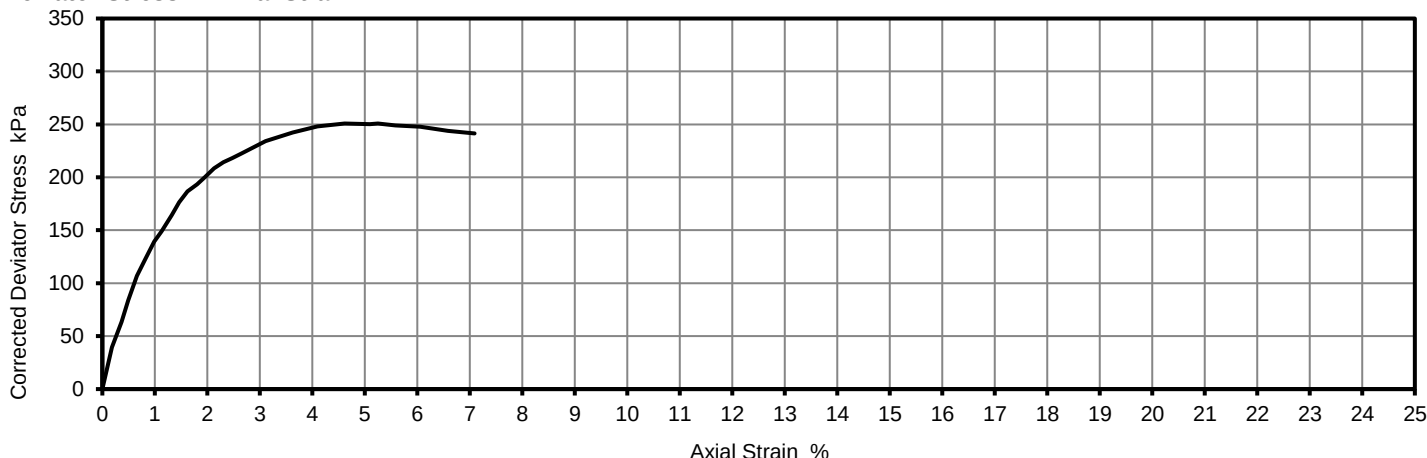
### Test Results:

Laboratory Reference: 2175669  
Hole No.: WS203  
Sample Reference: Not Given  
Sample Description: Brown CLAY  
Sample Preparation: Sample prepared in accordance with BS 1377-1:2016 Clause 9.1.1.

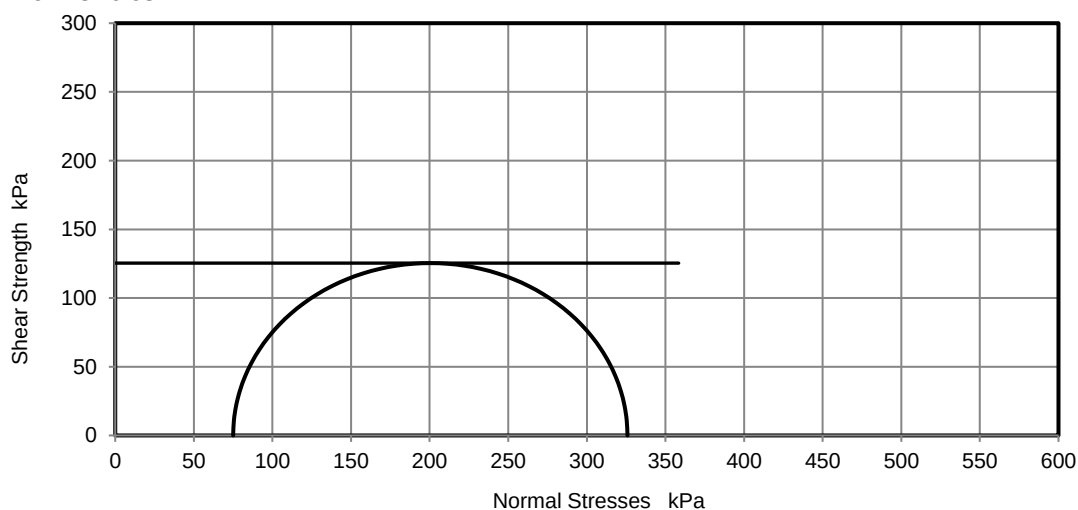
Depth Top [m]: 3.40  
Depth Base [m]: 4.00  
Sample Type: L

|                     |       |                                                         |         |                                          |
|---------------------|-------|---------------------------------------------------------|---------|------------------------------------------|
| Test Number         | 1     | Rate of Strain                                          | 2.00    | %/min                                    |
| Length              | 77.15 | Cell Pressure                                           | 75      | kPa                                      |
| Diameter            | 37.68 | Axial Strain at failure                                 | 4.6     | %                                        |
| Bulk Density        | 1.95  | Deviator Stress, ( $\sigma_1 - \sigma_3$ ) <sub>f</sub> | 251     | kPa                                      |
| Moisture Content    | 29    | Undrained Shear Strength, $c_u$                         | 125     | kPa $\frac{1}{2}(\sigma_1 - \sigma_3)_f$ |
| Dry Density         | 1.51  | Mode of Failure                                         | Brittle |                                          |
| Membrane Correction | 0.64  | Membrane thickness                                      | 0.19    | mm                                       |

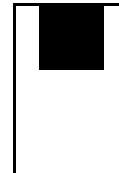
### Deviator Stress v Axial Strain



### Mohr Circles



Position within sample



Note: Deviator stress corrected for area change and membrane effects. Mohr circles and their interpretation is not covered by BS1377.  
This is provided for information only.

### Remarks:

### Signed:

Anna Dudzinska  
Deputy Head of Geo Office Section  
for and on behalf of i2 Analytical Ltd

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*Anna Dudzinska*

**Antony Platt**  
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e: reception@i2analytical.com

## **Analytical Report Number : 22-40201**

|                             |                        |                                                        |            |
|-----------------------------|------------------------|--------------------------------------------------------|------------|
| <b>Project / Site name:</b> | North Street, Emsworth | <b>Samples received on:</b>                            | 14/02/2022 |
| <b>Your job number:</b>     | J22-014                | <b>Samples instructed on/<br/>Analysis started on:</b> | 16/02/2022 |
| <b>Your order number:</b>   |                        | <b>Analysis completed by:</b>                          | 03/03/2022 |
| <b>Report Issue Number:</b> | 1                      | <b>Report issued on:</b>                               | 04/03/2022 |
| <b>Samples Analysed:</b>    | 4 soil samples         |                                                        |            |

**Signed:** 

Anna Goc  
Technical Reviewer (Reporting Team)  
**For & on behalf of i2 Analytical Ltd.**

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

|           |                           |
|-----------|---------------------------|
| soils     | - 4 weeks from reporting  |
| leachates | - 2 weeks from reporting  |
| waters    | - 2 weeks from reporting  |
| asbestos  | - 6 months from reporting |

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.  
Application of uncertainty of measurement would provide a range within which the true result lies.  
An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 22-40201  
Project / Site name: North Street, Emsworth

|                                         |       |                    |                         |               |               |               |               |
|-----------------------------------------|-------|--------------------|-------------------------|---------------|---------------|---------------|---------------|
| Lab Sample Number                       |       |                    |                         | 2175674       | 2175675       | 2175676       | 2175677       |
| Sample Reference                        |       |                    |                         | WS201         | WS201         | WS202         | WS203         |
| Sample Number                           |       |                    |                         | None Supplied | None Supplied | None Supplied | None Supplied |
| Depth (m)                               |       |                    |                         | 0.30-0.50     | 1.50-2.00     | 4.50-5.00     | 0.50-1.00     |
| Date Sampled                            |       |                    |                         | Deviating     | Deviating     | Deviating     | Deviating     |
| Time Taken                              |       |                    |                         | None Supplied | None Supplied | None Supplied | None Supplied |
| Analytical Parameter<br>(Soil Analysis) | Units | Limit of detection | Accreditation<br>Status |               |               |               |               |
| Stone Content                           | %     | 0.1                | NONE                    | < 0.1         | < 0.1         | < 0.1         | < 0.1         |
| Moisture Content                        | %     | 0.01               | NONE                    | 11            | 15            | 18            | 19            |
| Total mass of sample received           | kg    | 0.001              | NONE                    | 1.0           | 0.30          | 2.0           | 1.0           |

#### General Inorganics

|                                                                         |          |         |        |      |       |       |       |
|-------------------------------------------------------------------------|----------|---------|--------|------|-------|-------|-------|
| pH - Automated                                                          | pH Units | N/A     | MCERTS | 9.8  | 8.0   | 8.0   | 7.8   |
| Total Sulphate as SO <sub>4</sub>                                       | %        | 0.005   | MCERTS | -    | 0.040 | 0.131 | 0.020 |
| Water Soluble Sulphate as SO <sub>4</sub> 16hr extraction (2:1)         | mg/kg    | 2.5     | MCERTS | 3500 | -     | -     | -     |
| Water Soluble SO <sub>4</sub> 16hr extraction (2:1 Leachate Equivalent) | g/l      | 0.00125 | MCERTS | 1.8  | 0.13  | 0.58  | 0.15  |
| Water Soluble SO <sub>4</sub> 16hr extraction (2:1 Leachate Equivalent) | mg/l     | 1.25    | MCERTS | 1760 | -     | -     | -     |
| Water Soluble Chloride (2:1) (leachate equivalent)                      | mg/l     | 0.5     | MCERTS | -    | 34    | 160   | 23    |
| Total Sulphur                                                           | %        | 0.005   | MCERTS | -    | 0.025 | 0.710 | 0.079 |
| Water Soluble Nitrate (2:1) as N (leachate equivalent)                  | mg/l     | 2       | NONE   | -    | < 2.0 | < 2.0 | < 2.0 |

#### Heavy Metals / Metalloids

|                                 |       |     |      |   |     |     |     |
|---------------------------------|-------|-----|------|---|-----|-----|-----|
| Magnesium (water soluble)       | mg/kg | 5   | NONE | - | 18  | 140 | 12  |
| Magnesium (leachate equivalent) | mg/l  | 2.5 | NONE | - | 8.8 | 71  | 5.7 |

U/S = Unsuitable Sample I/S = Insufficient Sample

**Analytical Report Number : 22-40201**

**Project / Site name: North Street, Emsworth**

\* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

| Lab Sample Number | Sample Reference | Sample Number | Depth (m) | Sample Description *            |
|-------------------|------------------|---------------|-----------|---------------------------------|
| 2175674           | WS201            | None Supplied | 0.30-0.50 | Grey clay and sand with gravel. |
| 2175675           | WS201            | None Supplied | 1.50-2.00 | Brown clay.                     |
| 2175676           | WS202            | None Supplied | 4.50-5.00 | Brown clay.                     |
| 2175677           | WS203            | None Supplied | 0.50-1.00 | Brown clay with gravel.         |

**Analytical Report Number : 22-40201**

**Project / Site name: North Street, Emsworth**

**Water matrix abbreviations:**

**Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)**

| Analytical Test Name                               | Analytical Method Description                                                                                                                             | Analytical Method Reference                                                                                             | Method number | Wet / Dry Analysis | Accreditation Status |
|----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|---------------|--------------------|----------------------|
| Sulphate, water soluble, in soil (16hr extraction) | Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent). | In house method.                                                                                                        | L038-PL       | D                  | MCERTS               |
| Magnesium, water soluble, in soil                  | Determination of water soluble magnesium by extraction with water followed by ICP-OES.                                                                    | In-house method based on TRL 447                                                                                        | L038-PL       | D                  | NONE                 |
| Moisture Content                                   | Moisture content, determined gravimetrically. (30 oC)                                                                                                     | In house method.                                                                                                        | L019-UK/PL    | W                  | NONE                 |
| pH in soil (automated)                             | Determination of pH in soil by addition of water followed by automated electrometric measurement.                                                         | In house method.                                                                                                        | L099-PL       | D                  | MCERTS               |
| Stones content of soil                             | Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.                               | In-house method based on British Standard Methods and MCERTS requirements.                                              | L019-UK/PL    | D                  | NONE                 |
| Total Sulphate in soil as %                        | Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.                                                                   | In house method.                                                                                                        | L038-PL       | D                  | MCERTS               |
| Total Sulphur in soil as %                         | Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES.                                      | In house method.                                                                                                        | L038-PL       | D                  | MCERTS               |
| Water Soluble Nitrate (2:1) as N in soil           | Determination of nitrate by reaction with sodium salicylate and colorimetry.                                                                              | In-house method based on Examination of Water and Wastewater & Polish Standard Method PN-82/C-04579.08, 2:1 extraction. | L078-PL       | W                  | NONE                 |
| Chloride, water soluble, in soil                   | Determination of Chloride colorimetrically by discrete analyser.                                                                                          | In house method.                                                                                                        | L082-PL       | D                  | MCERTS               |
| Sulphate, water soluble, in soil                   | Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent). | In house method.                                                                                                        | L038-PL       | D                  | MCERTS               |

**For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.**

**For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.**

**Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.**

**Unless otherwise indicated, site information, order number, project number, sampling date, time, sample reference and depth are provided by the client. The instructed on date indicates the date on which this information was provided to the laboratory.**

## Sample Deviation Report



**Analytical Report Number : 22-40201**

**Project / Site name: North Street, Emsworth**

This deviation report indicates the sample and test deviations that apply to the samples submitted for analysis. Please note that the associated result(s) may be unreliable and should be interpreted with care.

| Sample ID | Other ID      | Sample Type | Lab Sample Number | Sample Deviation | Test Name     | Test Ref      | Test Deviation |
|-----------|---------------|-------------|-------------------|------------------|---------------|---------------|----------------|
| WS201     | None Supplied | S           | 2175674           | a                | None Supplied | None Supplied | None Supplied  |
| WS201     | None Supplied | S           | 2175675           | a                | None Supplied | None Supplied | None Supplied  |
| WS202     | None Supplied | S           | 2175676           | a                | None Supplied | None Supplied | None Supplied  |
| WS203     | None Supplied | S           | 2175677           | a                | None Supplied | None Supplied | None Supplied  |



# M & H Testing Limited

## "Adding Quality To Construction"

Southfield, Barnfield Road, Charing Heath, Ashford, Kent, TN27 0BP  
Telephone: 01233 714051 Fax: 0700 601 9306  
www.mhtesting.co.uk

### DETERMINATION OF CALIFORNIA BEARING RATIO (C.B.R.)

Dynamic Deformation Modulus E<sub>vd</sub> - CBR

|              |                       |           |                             |
|--------------|-----------------------|-----------|-----------------------------|
| REPORT No.:  | MH22-11342-17-01-22-1 | CLIENT:   | Parchow Groundworks         |
| CLIENT REF:  | Foundation            | ADDRESS:  | New Down Lane Waterlooville |
| DATE TESTED: | 17 January 2022       | SITE:     | 31a North Street Emsworth   |
| TECHNICIAN:  | Sam Shea              | SUPPLIER: | Site Won                    |
| LOCATION:    | Foundation            | MATERIAL: | Light Brown Clay            |

### TEST RESULTS

| <i>Client Ref.</i> | <i>Location</i> | <i>Visual Material Description</i> | <i>In-situ CBR Value</i><br>% |
|--------------------|-----------------|------------------------------------|-------------------------------|
| Foundation         | 1               | Light Brown Clay                   | 7.0                           |
| Foundation         | 2               | Light Brown Clay                   | 6.5                           |

REMARKS: All CBR Values shown above are calculated using guidance notes from LWD Manufacturer documentation.  
This test report shall not be reproduced, except in full, without the written approval of M&H Testing Limited. These results relate only to the items tested.

18-Jan-22

Checked and verified by:  
Jon Champion  
General Manager

## **APPENDIX 4: GEOTECHNICAL CALCULATIONS**

|                                                                                  |                     |                                                                                                                               |      |                                                                                     |    |
|----------------------------------------------------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------|------|-------------------------------------------------------------------------------------|----|
| Project Title:                                                                   |                     | Emsworth                                                                                                                      |      |  |    |
| Shallow Foundation                                                               |                     | Strip Foundation                                                                                                              |      |                                                                                     |    |
| Determination of Bearing Resistance                                              |                     | Calcs by                                                                                                                      | DF   | Checked by                                                                          | RP |
| London Clay Formation                                                            |                     |                                                                                                                               |      |                                                                                     |    |
| <b><u>Design Approach 1</u></b>                                                  |                     | <b><u>Characteristic Geotechnical Parameters</u></b>                                                                          |      |                                                                                     |    |
| Combination 1 A1 + M1 + R1                                                       | Unit Weight         | 19                                                                                                                            |      |                                                                                     |    |
|                                                                                  | Undrained Cohesion  | 60                                                                                                                            |      |                                                                                     |    |
|                                                                                  | Cohesion            | 0                                                                                                                             |      |                                                                                     |    |
|                                                                                  | Shearing Resistance | 22                                                                                                                            |      |                                                                                     |    |
| <b><u>Material Properties and Resistance</u></b>                                 |                     | <b><u>Foundation Size</u></b>                                                                                                 |      |                                                                                     |    |
| Partial factors set M1: $\gamma_{cu} = 1$ $\gamma_{\phi} = 1$ and $\gamma_c = 1$ |                     | depth                                                                                                                         | 1.00 |                                                                                     |    |
|                                                                                  |                     | breadth                                                                                                                       | 0.60 |                                                                                     |    |
|                                                                                  |                     | $c_{ud} = \frac{c_{uk}}{\gamma_{cu}} = 60$                                                                                    |      |                                                                                     |    |
| Design shearing resistance is                                                    |                     | $\phi_d = \tan^{-1} \left( \frac{\tan \phi_K}{\gamma_{\phi}} \right) = 22$                                                    |      |                                                                                     |    |
| Design cohesion is                                                               |                     | $c'_d = \frac{c_k}{\gamma_c} = 0$                                                                                             |      |                                                                                     |    |
| <b><u>Drained Bearing Capacity Factors</u></b>                                   |                     |                                                                                                                               |      |                                                                                     |    |
| For overburden                                                                   |                     | $N_q = \left[ e^{(\pi \times \tan(\phi_d))} \times \left( \tan \left( 45 + \frac{\phi_d}{2} \right) \right)^2 \right] = 7.82$ |      |                                                                                     |    |
| For cohesion                                                                     |                     | $N_c = [(N_q - 1) \times \cot(\phi_d)] = 16.87$                                                                               |      |                                                                                     |    |
| For self-weight                                                                  |                     | $N_{\gamma} = [2(N_q - 1) \times \tan(\phi_d)] = 5.51$                                                                        |      |                                                                                     |    |
| <b><u>Depth and Shape Factors</u></b>                                            |                     |                                                                                                                               |      |                                                                                     |    |
| Solgado's depth factor for undrained loading:                                    |                     | $d_c = 1 + 0.27 \sqrt{\frac{d}{B}} = 1.35$                                                                                    |      |                                                                                     |    |
| Ignore depth factors for drained loading                                         |                     |                                                                                                                               |      |                                                                                     |    |
| Solgado's shape factor for undrained loading:                                    |                     | $s_c = 1 + 0.17 \sqrt{\frac{d}{B}} = 1.22$                                                                                    |      |                                                                                     |    |
| Shape factors are all 1.0 for drained loading and so can be ignored              |                     |                                                                                                                               |      |                                                                                     |    |
| <b><u>Undrained Bearing Resistance</u></b>                                       |                     |                                                                                                                               |      |                                                                                     |    |
| Total overburden at foundation base is                                           |                     | $\sigma_{vk,b} = \gamma_k \times d = 19$                                                                                      |      |                                                                                     |    |
| Partial factors set R1: $\gamma_{Rv} = 1$                                        |                     |                                                                                                                               |      |                                                                                     |    |
| Ultimate resistance is                                                           |                     | $q_{ult} = (\pi + 2) \times c_{ud} \times d_c \times s_c + \sigma_{vk,b} = 526$                                               |      |                                                                                     |    |
| Design Resistance is                                                             |                     | $q_{Rd} = \frac{q_{ult}}{\gamma_{Rv}} = 526$                                                                                  |      |                                                                                     |    |

|                                                                                              |                                                                                                                          |                      |    |                                                                                     |    |
|----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|----------------------|----|-------------------------------------------------------------------------------------|----|
| Project Title:                                                                               |                                                                                                                          | Emsworth             |    |  |    |
| Shallow Foundation                                                                           |                                                                                                                          | Strip Foundation     |    |                                                                                     |    |
| Determination of Bearing Resistance                                                          |                                                                                                                          | Calcs by             | DF | Checked by                                                                          | RP |
| <u>Drained Bearing Resistance</u>                                                            |                                                                                                                          | Depth to Groundwater |    | 1                                                                                   |    |
| Effective overburden at foundation base is $\sigma'_{vk,b} = \sigma_{vk,b} - u_{k,b} = 19.0$ |                                                                                                                          |                      |    |                                                                                     |    |
| From overburden                                                                              | $q'_{ult_1} = N_q \times \sigma'_{wk,b} =$                                                                               | 149                  |    |                                                                                     |    |
| From cohesion                                                                                | $q'_{ult_2} = N_c \times c'_d =$                                                                                         | 0                    |    |                                                                                     |    |
| From self-weight                                                                             | $q'_{ult_3} = \left[ N_\gamma \times (\gamma_k - \gamma_w) \times \frac{B}{2} \right] =$                                 | 31                   |    | 16                                                                                  |    |
| Total resistance is                                                                          | $q'_{ult} = \sum_{i=1}^3 q'_{ult_i} =$                                                                                   | 165                  |    |                                                                                     |    |
| Design resistance is                                                                         | $q'_{Rd} = \frac{q'_{ult}}{\gamma_{Rv}} =$                                                                               | 165                  |    |                                                                                     |    |
| <b><u>Design Approach 1</u></b>                                                              |                                                                                                                          |                      |    |                                                                                     |    |
| Combination 2 A2 + M2 + R1                                                                   |                                                                                                                          |                      |    |                                                                                     |    |
| <u>Material Properties and Resistance</u>                                                    |                                                                                                                          |                      |    |                                                                                     |    |
| Partial factors set M2: $\gamma_{cu} = 1.4$ $\gamma_\phi = 1.25$ and $\gamma_c = 1.25$       |                                                                                                                          |                      |    |                                                                                     |    |
| Design undrained strength is                                                                 | $c_{ud} = \frac{c_{uk}}{\gamma_{cu}} =$                                                                                  | 43                   |    |                                                                                     |    |
| Design shearing resistance is                                                                | $\phi_d = \tan^{-1} \left( \frac{\tan \phi_k}{\gamma_\phi} \right) =$                                                    | 18                   |    |                                                                                     |    |
| Design cohesion is                                                                           | $c'_d = \frac{c_k}{\gamma_c} =$                                                                                          | 0                    |    |                                                                                     |    |
| <u>Drained Bearing Capacity Factors</u>                                                      |                                                                                                                          |                      |    |                                                                                     |    |
| For overburden                                                                               | $N_q = \left[ e^{(\pi \times \tan(\phi_d))} \times \left( \tan \left( 45 + \frac{\phi_d}{2} \right) \right)^2 \right] =$ | 5.21                 |    |                                                                                     |    |
| For cohesion                                                                                 | $N_c = [(N_q - 1) \times \cot(\phi_d)] =$                                                                                | 13.03                |    |                                                                                     |    |
| For self-weight                                                                              | $N_\gamma = [2(N_q - 1) \times \tan(\phi_d)] =$                                                                          | 2.72                 |    |                                                                                     |    |

|                                                                     |               |                                                                                             |            |    |
|---------------------------------------------------------------------|---------------|---------------------------------------------------------------------------------------------|------------|----|
| Project Title: Emsworth                                             |               |          |            |    |
| Shallow Foundation                                                  |               | Strip Foundation                                                                            |            |    |
| Determination of Bearing Resistance                                 | Calcs by      | DF                                                                                          | Checked by | RP |
| <u>Depth and Shape Factors</u>                                      |               |                                                                                             |            |    |
| Solgado's depth factor for undrained loading:                       |               | $d_c = 1 + 0.27 \sqrt{\frac{d}{B}} = 1.35$                                                  |            |    |
| Ignore depth factors for drained loading                            |               |                                                                                             |            |    |
| Solgado's shape factor for undrained loading:                       |               | $s_c = 1 + 0.17 \sqrt{\frac{d}{B}} = 1.22$                                                  |            |    |
| Shape factors are all 1.0 for drained loading and so can be ignored |               |                                                                                             |            |    |
| <u>Undrained Bearing Resitance</u>                                  |               |                                                                                             |            |    |
| Total overburden at foundation base is                              |               | $\sigma_{vk,b} = \gamma_k \times d = 19$                                                    |            |    |
| Partial factors set R1: $\gamma_{Rv} = 1$                           |               |                                                                                             |            |    |
| Ultimate resistance is                                              |               | $q_{ult} = (\pi + 2) \times c_{ud} \times d_c \times s_c + \sigma_{vk,b} = 381$             |            |    |
| Design Resistance is                                                |               | $q_{Rd} = \frac{q_{ult}}{\gamma_{Rv}} = 381$                                                |            |    |
| <u>Drained Bearing Resistance</u>                                   |               |                                                                                             |            |    |
| Effective overburden at foundation base is                          |               | $\sigma'_{vk,b} = \sigma_{vk,b} - u_{k,b} = 19.00$                                          |            |    |
| From overburden                                                     |               | $q'_{ult_1} = N_q \times \sigma'_{wk,b} = 99$                                               |            |    |
| From cohesion                                                       |               | $q'_{ult_2} = N_c \times c'_d = 0$                                                          |            |    |
| From self-weight                                                    |               | $q'_{ult_3} = \left[ N_\gamma \times (\gamma_k - \gamma_w) \times \frac{B}{2} \right] = 16$ |            |    |
| Total resistance is                                                 |               | $q'_{ult} = \sum_{i=1}^3 q'_{ult_i} = 107$                                                  |            |    |
| Design Resistance is                                                |               | $q'_{Rd} = \frac{q'_{ult}}{\gamma_{Rv}} = 107$                                              |            |    |
| Design Approach                                                     | Combination   | Design Resistance                                                                           |            |    |
|                                                                     |               | ULS (kN/m <sup>2</sup> )                                                                    |            |    |
|                                                                     |               | undrained                                                                                   | drained    |    |
| DA1                                                                 | Combination 1 | 526                                                                                         | 165        |    |
|                                                                     | Combination 2 | 381                                                                                         | 107        |    |

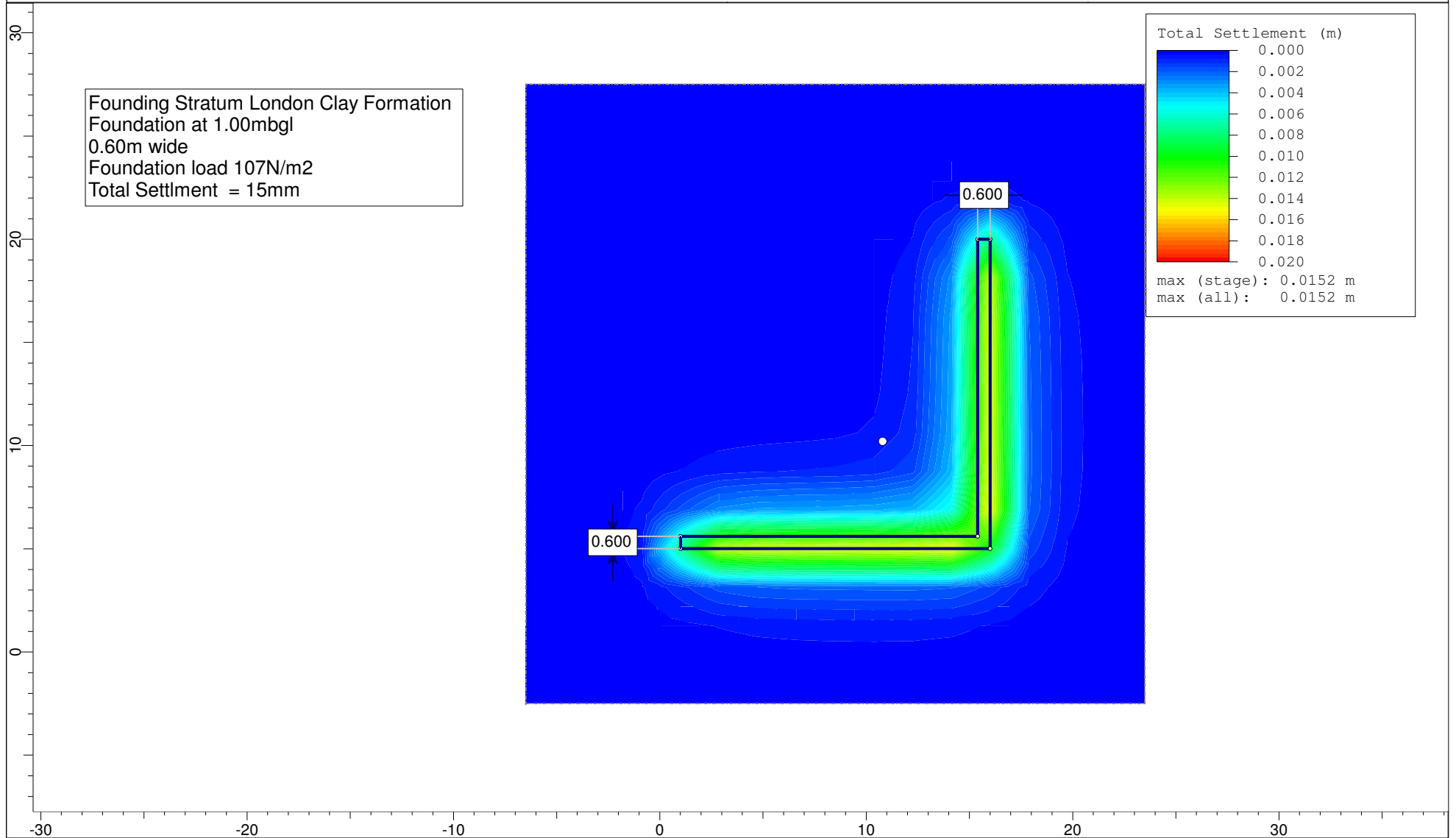
|                                                                                  |                     |                                                                                                                               |      |                                                                                     |    |
|----------------------------------------------------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------|------|-------------------------------------------------------------------------------------|----|
| Project Title:                                                                   |                     | Emsworth                                                                                                                      |      |  |    |
| Shallow Foundation                                                               |                     | Strip Foundation                                                                                                              |      |                                                                                     |    |
| Determination of Bearing Resistance                                              |                     | Calcs by                                                                                                                      | DF   | Checked by                                                                          | RP |
| London Clay Formation                                                            |                     |                                                                                                                               |      |                                                                                     |    |
| <b><u>Design Approach 1</u></b>                                                  |                     | <b><u>Characteristic Geotechnical Parameters</u></b>                                                                          |      |                                                                                     |    |
| Combination 1 A1 + M1 + R1                                                       | Unit Weight         | 19                                                                                                                            |      |                                                                                     |    |
|                                                                                  | Undrained Cohesion  | 60                                                                                                                            |      |                                                                                     |    |
|                                                                                  | Cohesion            | 0                                                                                                                             |      |                                                                                     |    |
|                                                                                  | Shearing Resistance | 22                                                                                                                            |      |                                                                                     |    |
| <b><u>Material Properties and Resistance</u></b>                                 |                     | <b><u>Foundation Size</u></b>                                                                                                 |      |                                                                                     |    |
| Partial factors set M1: $\gamma_{cu} = 1$ $\gamma_{\phi} = 1$ and $\gamma_c = 1$ |                     | depth                                                                                                                         | 1.00 |                                                                                     |    |
|                                                                                  |                     | breadth                                                                                                                       | 1.00 |                                                                                     |    |
|                                                                                  |                     | $c_{ud} = \frac{c_{uk}}{\gamma_{cu}} = 60$                                                                                    |      |                                                                                     |    |
| Design shearing resistance is                                                    |                     | $\phi_d = \tan^{-1} \left( \frac{\tan \phi_K}{\gamma_{\phi}} \right) = 22$                                                    |      |                                                                                     |    |
| Design cohesion is                                                               |                     | $c'_d = \frac{c_k}{\gamma_c} = 0$                                                                                             |      |                                                                                     |    |
| <b><u>Drained Bearing Capacity Factors</u></b>                                   |                     |                                                                                                                               |      |                                                                                     |    |
| For overburden                                                                   |                     | $N_q = \left[ e^{(\pi \times \tan(\phi_d))} \times \left( \tan \left( 45 + \frac{\phi_d}{2} \right) \right)^2 \right] = 7.82$ |      |                                                                                     |    |
| For cohesion                                                                     |                     | $N_c = [(N_q - 1) \times \cot(\phi_d)] = 16.87$                                                                               |      |                                                                                     |    |
| For self-weight                                                                  |                     | $N_{\gamma} = [2(N_q - 1) \times \tan(\phi_d)] = 5.51$                                                                        |      |                                                                                     |    |
| <b><u>Depth and Shape Factors</u></b>                                            |                     |                                                                                                                               |      |                                                                                     |    |
| Solgado's depth factor for undrained loading:                                    |                     | $d_c = 1 + 0.27 \sqrt{\frac{d}{B}} = 1.27$                                                                                    |      |                                                                                     |    |
| Ignore depth factors for drained loading                                         |                     |                                                                                                                               |      |                                                                                     |    |
| Solgado's shape factor for undrained loading:                                    |                     | $s_c = 1 + 0.17 \sqrt{\frac{d}{B}} = 1.17$                                                                                    |      |                                                                                     |    |
| Shape factors are all 1.0 for drained loading and so can be ignored              |                     |                                                                                                                               |      |                                                                                     |    |
| <b><u>Undrained Bearing Resistance</u></b>                                       |                     |                                                                                                                               |      |                                                                                     |    |
| Total overburden at foundation base is                                           |                     | $\sigma_{vk,b} = \gamma_k \times d = 19$                                                                                      |      |                                                                                     |    |
| Partial factors set R1: $\gamma_{Rv} = 1$                                        |                     |                                                                                                                               |      |                                                                                     |    |
| Ultimate resistance is                                                           |                     | $q_{ult} = (\pi + 2) \times c_{ud} \times d_c \times s_c + \sigma_{vk,b} = 477$                                               |      |                                                                                     |    |
| Design Resistance is                                                             |                     | $q_{Rd} = \frac{q_{ult}}{\gamma_{Rv}} = 477$                                                                                  |      |                                                                                     |    |

|                                                                                              |                                                                                                                          |                      |    |                                                                                     |    |
|----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|----------------------|----|-------------------------------------------------------------------------------------|----|
| Project Title:                                                                               |                                                                                                                          | Emsworth             |    |  |    |
| Shallow Foundation                                                                           |                                                                                                                          | Strip Foundation     |    |                                                                                     |    |
| Determination of Bearing Resistance                                                          |                                                                                                                          | Calcs by             | DF | Checked by                                                                          | RP |
| <u>Drained Bearing Resistance</u>                                                            |                                                                                                                          | Depth to Groundwater |    | 1                                                                                   |    |
| Effective overburden at foundation base is $\sigma'_{vk,b} = \sigma_{vk,b} - u_{k,b} = 19.0$ |                                                                                                                          |                      |    |                                                                                     |    |
| From overburden                                                                              | $q'_{ult_1} = N_q \times \sigma'_{wk,b} =$                                                                               | 149                  |    |                                                                                     |    |
| From cohesion                                                                                | $q'_{ult_2} = N_C \times c'_d =$                                                                                         | 0                    |    |                                                                                     |    |
| From self-weight                                                                             | $q'_{ult_3} = \left[ N_\gamma \times (\gamma_k - \gamma_w) \times \frac{B}{2} \right] =$                                 | 52                   |    | 26                                                                                  |    |
| Total resistance is                                                                          | $q'_{ult} = \sum_{i=1}^3 q'_{ult_i} =$                                                                                   | 175                  |    |                                                                                     |    |
| Design resistance is                                                                         | $q'_{Rd} = \frac{q'_{ult}}{\gamma_{Rv}} =$                                                                               | 175                  |    |                                                                                     |    |
| <b><u>Design Approach 1</u></b>                                                              |                                                                                                                          |                      |    |                                                                                     |    |
| Combination 2 A2 + M2 + R1                                                                   |                                                                                                                          |                      |    |                                                                                     |    |
| <u>Material Properties and Resistance</u>                                                    |                                                                                                                          |                      |    |                                                                                     |    |
| Partial factors set M2: $\gamma_{cu} = 1.4$ $\gamma_\phi = 1.25$ and $\gamma_c = 1.25$       |                                                                                                                          |                      |    |                                                                                     |    |
| Design undrained strength is                                                                 | $c_{ud} = \frac{c_{uk}}{\gamma_{cu}} =$                                                                                  | 43                   |    |                                                                                     |    |
| Design shearing resistance is                                                                | $\phi_d = \tan^{-1} \left( \frac{\tan \phi_K}{\gamma_\phi} \right) =$                                                    | 18                   |    |                                                                                     |    |
| Design cohesion is                                                                           | $c'_d = \frac{c_k}{\gamma_c} =$                                                                                          | 0                    |    |                                                                                     |    |
| <u>Drained Bearing Capacity Factors</u>                                                      |                                                                                                                          |                      |    |                                                                                     |    |
| For overburden                                                                               | $N_q = \left[ e^{(\pi \times \tan(\phi_d))} \times \left( \tan \left( 45 + \frac{\phi_d}{2} \right) \right)^2 \right] =$ | 5.21                 |    |                                                                                     |    |
| For cohesion                                                                                 | $N_c = [(N_q - 1) \times \cot(\phi_d)] =$                                                                                | 13.03                |    |                                                                                     |    |
| For self-weight                                                                              | $N_\gamma = [2(N_q - 1) \times \tan(\phi_d)] =$                                                                          | 2.72                 |    |                                                                                     |    |

|                                                                     |               |                                                                                        |            |    |
|---------------------------------------------------------------------|---------------|----------------------------------------------------------------------------------------|------------|----|
| Project Title: Emsworth                                             |               |     |            |    |
| Shallow Foundation                                                  |               | Strip Foundation                                                                       |            |    |
| Determination of Bearing Resistance                                 | Calcs by      | DF                                                                                     | Checked by | RP |
| <u>Depth and Shape Factors</u>                                      |               |                                                                                        |            |    |
| Solgado's depth factor for undrained loading:                       |               | $d_c = 1 + 0.27 \sqrt{\frac{d}{B}} =$                                                  | 1.27       |    |
| Ignore depth factors for drained loading                            |               |                                                                                        |            |    |
| Solgado's shape factor for undrained loading:                       |               | $s_c = 1 + 0.17 \sqrt{\frac{d}{B}} =$                                                  | 1.17       |    |
| Shape factors are all 1.0 for drained loading and so can be ignored |               |                                                                                        |            |    |
| <u>Undrained Bearing Resitance</u>                                  |               |                                                                                        |            |    |
| Total overburden at foundation base is                              |               | $\sigma_{vk,b} = \gamma_k \times d =$                                                  | 19         |    |
| Partial factors set R1: $\gamma_{Rv} = 1$                           |               |                                                                                        |            |    |
| Ultimate resistance is                                              |               | $q_{ult} = (\pi + 2) \times c_{ud} \times d_c \times s_c + \sigma_{vk,b} =$            | 346        |    |
| Design Resistance is                                                |               | $q_{Rd} = \frac{q_{ult}}{\gamma_{Rv}} =$                                               | 346        |    |
| <u>Drained Bearing Resistance</u>                                   |               |                                                                                        |            |    |
| Effective overburden at foundation base is                          |               | $\sigma'_{vk,b} = \sigma_{vk,b} - u_{k,b} =$                                           | 19.00      |    |
| From overburden                                                     |               | $q'_{ult_1} = N_q \times \sigma'_{wk,b} =$                                             | 99         |    |
| From cohesion                                                       |               | $q'_{ult_2} = N_c \times c'_d =$                                                       | 0          |    |
| From self-weight                                                    |               | $q'_{ult_3} = \left[ N_\gamma \times (\gamma_k - \gamma_w) \times \frac{B}{2} \right]$ | 26         | 13 |
| Total resistance is                                                 |               | $q'_{ult} = \sum_{i=1}^3 q'_{ult_i} =$                                                 | 112        |    |
| Design Resistance is                                                |               | $q'_{Rd} = \frac{q'_{ult}}{\gamma_{Rv}} =$                                             | 112        |    |
| Design Approach                                                     | Combination   | Design Resistance                                                                      |            |    |
|                                                                     |               | ULS (kN/m <sup>2</sup> )                                                               |            |    |
|                                                                     |               | undrained                                                                              | drained    |    |
| DA1                                                                 | Combination 1 | 477                                                                                    | 175        |    |
|                                                                     | Combination 2 | 346                                                                                    | 112        |    |

Stage 1

Data Type: Total Settlement

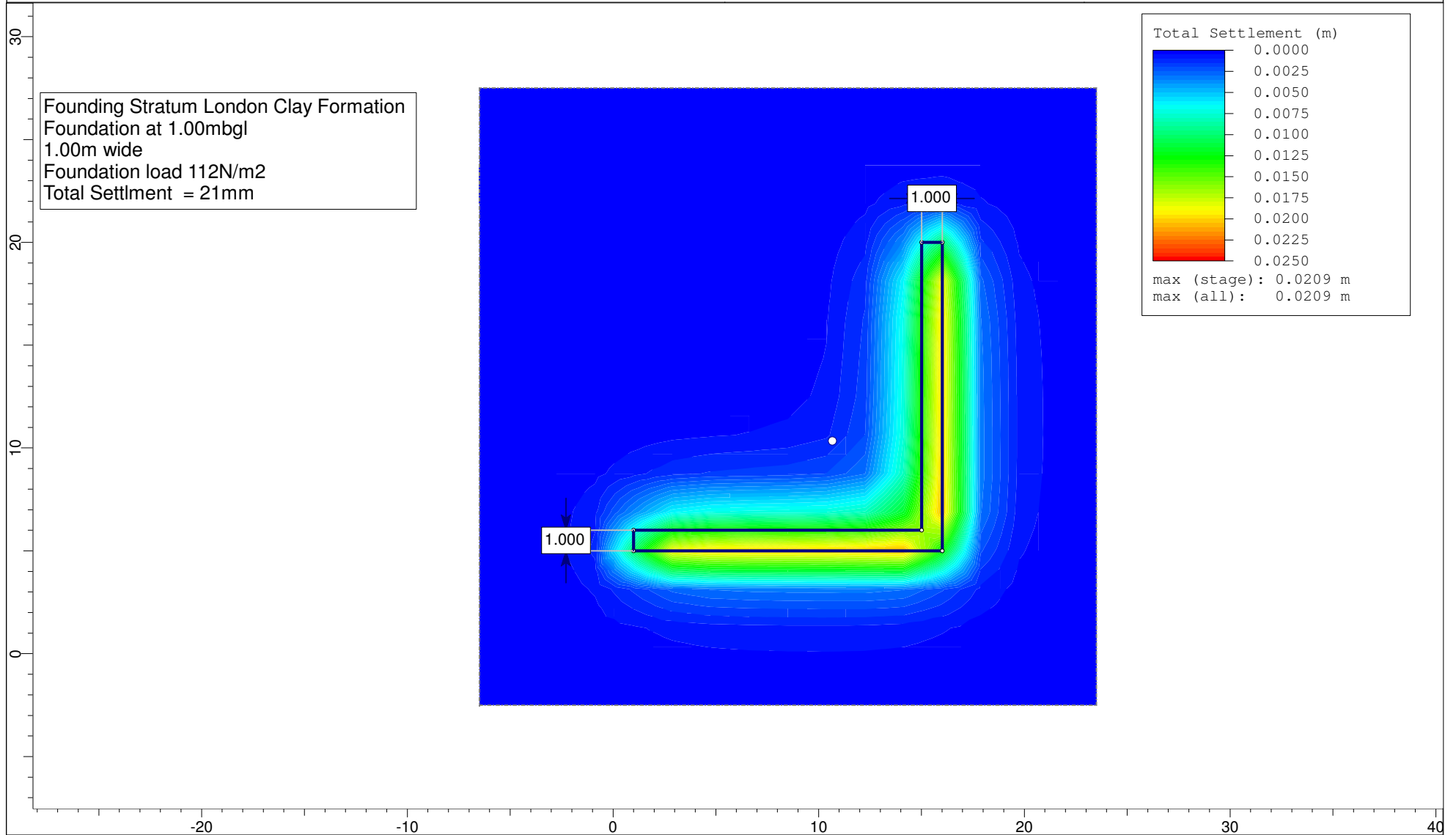


SETTLE3D 2.010

|                      |               |                  |                              |
|----------------------|---------------|------------------|------------------------------|
| Project              |               | Emsworth         |                              |
| Analysis Description |               | Strip Foundation |                              |
| Drawn By             | Dr David Fall | Company          | Ground Conditons Consultants |
| Date                 | 30/03/2022    | File Name        | Settlement Strip 1.s3z       |

Stage 1

Data Type: Total Settlement



SETTLE3D 2.010

|                      |                  |           |                              |
|----------------------|------------------|-----------|------------------------------|
| Project              | Emsworth         |           |                              |
| Analysis Description | Strip Foundation |           |                              |
| Drawn By             | Dr David Fall    | Company   | Ground Conditons Consultants |
| Date                 | 30/03/2022       | File Name | Settlement Strip 1.s3z       |